Plus One Serve by 2030

VG23005 – National Strategy and Baseline Review*

A bold, collaborative and innovative approach to increasing Australia's vegetable consumption

June 2024

Contributors and Acknowledgements

The insights and collaborative efforts of various stakeholders and experts have been instrumental in the development of this report, aimed at addressing the imperative of increasing vegetable consumption in alignment with the 'Plus One Serve by 2030' initiative. Their collective expertise and dedication have shaped a comprehensive analysis and strategic roadmap to promote healthier dietary habits across Australia, emphasising the pivotal role of vegetables in enhancing public health and agricultural sustainability.

Special gratitude is extended to the following organisations for their invaluable contributions to this endeavour:

AgEcon
AIA
AUSVEG
Cancer Council Victoria
Coles Group
Compass Group
Corporate Value Associates (Australia)
Crunch & Sip
Deakin University
Eat Well Tasmania
Edith Cowan University
End Food Waste Australia
Food Bank Victoria
Food Bank WA
FoodIQ
Fresh Markets Australia
Fresh Produce Group
The George Institute
Health and Wellbeing Queensland
Health New South Wales
Healthy Kids
Kitchen Garden Foundation
Macquarie University
Melbourne Market Authority
Newcastle University
Nielsen IQ
NSW Cancer Council
Nutrition Australia
Perfection Fresh Australia
Queensland Association of School Tuckshops
CSIRO
Simplot
The Shannon Company
University of Melbourne
University of Queensland
VEG Education
Velisha Farms
Zoo Republic

Their collective wisdom and commitment have been pivotal in shaping this report into a credible and actionable resource for policymakers, industry leaders, and the wider community. It is through their collaborative efforts that progress towards achieving the 'Plus One Serve by 2030' initiative and fostering a healthier, more sustainable future for Australia is made possible.

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This project has been funded by Hort Innovation, using the <insert industry> research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Hort Frontiers – R&D projects

<Insert project name> is funded by the Hort Frontiers <insert fund name>, part of the Hort Frontiers strategic partnership initiative developed by Hort Innovation, with co-investment from <insert list of contributing partners> and contributions from the Australian Government.

Publishing details:

ISBN <Hort Innovation to add>

Published and distributed by: Horticulture Innovation Australia Limited
ABN 71 602100149

Level 7
141 Walker Street
North Sydney NSW 2060

Telephone: (02) 8295 2300

www.horticulture.com.au

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Abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
AIHW	Australian Institute of Health and Welfare
BCR	Benefit cost ratio
CALD	Culturally and linguistically diverse
CHD	Coronary heart disease
CVD	Cardiovascular disease
DCF	Discounted cashflow
ELEC	Early learning education centres
ESG	Environmental, social, and governance
FIAL	Food Innovation Australia
FTE	Full Time Equivalent
FVC	Fruit and Vegetable Consortium
GVP	Gross value of production
NHANES	National Health and Nutrition Examination Survey
NHMRC	National Health and Medical Research Council
NHS	National Health Service
NPV	Net present value
OSHC	Out of school hours care
PI(E)COC	Population, Intervention / Exposure, Comparison, Outcome, Setting and Study Design
PVB	Present value of benefits
PVC	Present value of costs
QSR	Quick-service restaurants
ROBIS	Risk of Bias in Systematic Reviews
SES	Socio-economic status
SMD	Standardised Mean Difference
WHO	World Health Organisation

Executive summary

Introduction: Addressing the vegetable consumption crisis in Australia

This paper introduces the VG23005 – National Strategy, Baseline, and Value Perception Study, which addresses the critical need to increase vegetable consumption in Australia. Acknowledging the established benefits of a diet rich in fruits and vegetables for minimising the risk of heart disease and diabetes, the National Health and Medical Research Council (NHMRC, 2013) outlines daily vegetable intake recommendations at 5 serves per person per day. These guidelines are designed to optimise health and nutrition across different age and gender groups. Despite these recommendations, there exists a significant discrepancy between recommended and actual vegetable consumption levels in Australia.

The “Shifting the Dial” research (2022) reported that 91% of Australians were not eating their recommended 5 serves per day and 25% were eating one serve or less. The report also showed that only 6% of Australian children were consuming the recommended daily serves of vegetables. This alarmingly low and decreasing level of vegetable intake amongst Australians is a national crisis that requires urgent government and cross-sector, collaborative action.

Self-reported surveys indicate that the average vegetable intake among Australians stands at approximately 2.4 serves per day (AIHW, 2022), starkly lower than the NHMRC's (2013) suggestion of 5 daily serves.

Very low vegetable consumption poses a risk to Australians’ health and impacts the economic sustainability of vegetable growers. This report details the importance of vegetables for a healthy diet and the economic and environmental benefits of increased vegetable consumption.

The VG23005 study seeks to underpin the 'Plus One Serve by 2030' initiative. This initiative, part of a six-year vegetable demand creation program under the Hort Frontiers Health, Nutrition, and Food Safety Fund, aims to elevate vegetable consumption through a bottom-up, data-driven approach.

The backdrop of declining vegetable consumption elucidates the critical objectives of the VG23005 study. By establishing a comprehensive baseline and understanding value perceptions, the initiative aims to substantially increase vegetable intake by 2030, thereby contributing to public health improvement and agricultural sustainability in Australia.

The “Shifting the Dial” report recommended the development of a national “Plus One Serve” strategy, like successful programs in other countries or sectors. This strategy would be fully integrated across the sector and address key barriers to consumption including perceived affordability, waste and preparation – as well as update the baseline for consumption in Australia. A settings-based approach was recommended with retail, home and education established as priorities.

The research outlined in this paper underpins the development of a successful strategy including a thorough review of past interventions, an update of baseline vegetable consumption, the development of strategic frameworks and budgets, and an analysis of outcomes and impacts. This will inform investment by vegetable industry stakeholders, researchers and Governments over the next six (6) years.

Key objectives of this project

The project's objectives were structured to support the overarching goal of increasing vegetable consumption in Australia, underpinning the 'Plus One Serve by 2030' initiative through evidence-based strategies and stakeholder engagement.

The project had several modules.

Module 1: Rapid review of global best practice

a. Consolidating the evidence on the effectiveness of strategies to promote vegetable consumption in priority settings.

Module 2: A proposed new methodology to quantify baseline vegetable consumption in Australia

As an outcome of the *Shifting the Dial* report 2022 - it was concluded by industry via the FVC that an update to the baseline methodology was needed. A new baseline methodology could provide several benefits.

a. More accurately demonstrate the base and hence the scale of the problem of low vegetable consumption in Australia and its cost to the industry and community.
b. Provide a better baseline for settings and hence measurement of success of future investment in interventions at the settings level.
c. Provide more granularity and insights into consumption issues and hot spots within particular demographics or categories. This can inform interventions, communication and core research.
d. For the first time include vegetable waste in the analysis and grow our understanding of waste in the sector
e. Lower the cost of calculating the baseline and make it easier to update each year.

Module 3: Plus One Serve Investment Scenarios

a. Understand the elements of a successful national change program and co-design frameworks for the Plus One Serve approach.
b. Develop the Behavioural Intervention Framework for a national Plus One Serve program that describe future governance, project KPI's, project multi-criteria assessment, support functions especially communications and monitoring/evaluation.
c. Analyse the current "vegetable consumption" spend across all stakeholders and understand the current impact of this spend.
d. Using inputs from international programs and the co-design process, build plausible investment scenarios that could support an increased effort in a national change program – Plus One Serve - across priority settings.
e. Build funding models for four scenarios, low, medium, high and optimal that map financials across an initial 6 year Plus One Serve program plus a further ten years of estimates (total 16 years of estimates). The model's details will inform a cost/benefit and economic impact analysis of the investment scenarios.

Module 4: Economic Impact Assessment

a. To quantify the expected economic and social impacts of increasing vegetable consumption through delivery of the *Plus One Serve of Vegetables by 2030* (Plus One Serve) Program. Understanding the potential impact of the Plus One Serve Program is required to inform delivery strategy, prioritise investment and communicate value of the Program.

Overall project methodology (VG230025)

The project methodology was broken into five key stages:

Figure 1 Project methodology summary

Note: an additional Value Perception Study was also conducted during this project – the outcomes of which are reported separately.

1. **Module 1: Rapid review of best practice interventions**

CSIRO, supported by the FVC Research Committee, conducted a comprehensive review of global best practices in interventions aimed at increasing vegetable consumption, tailoring findings to the Australian context. This involved synthesising existing systematic reviews on relevant interventions across the priority settings. The review quantified the potential impact of interventions by setting, and intervention strategies by setting, in terms of a change in vegetable consumption. These findings were used to inform the investment scenarios.

2. **Module 2: Review and update national baseline for vegetable consumption**

CVA Australia updated and refined the existing baseline for vegetable consumption in Australia, aiming for enhanced accuracy and granularity across different settings and demographics. This task involved reviewing available data sources, identifying and filling data gaps through stakeholder engagement and literature reviews, and making simplifying assumptions where necessary. The updated baseline was then visualized using a Power BI dashboard, facilitating easy access to granular consumption data and enabling future updates.

3. **Module 3: Development of investment scenarios**

Part A: The new **'Plus One Serve' Behavioural Intervention Framework** was developed through an evolving co- design process using:

Academic based frameworks developed over the last 13 years by Prof. Susan Michie's of University College of London Behaviour Change Wheel first developed in 2011 following a literature and practice review and then analysis of major health programs in the UK

The Shannon Company's and Monash BehaviourWorks intervention framework derived through practical application and review of Australia's successful long term change programs including – smoking cessation (QUIT), retirement saving/ superannuation (Industry Super Funds), women's health (This Girl Can), Water conservation during the Millennium drought (our water our future) and commercial success for increasing per capita consumption of Salmon with Tassal in 2018.

Dr Mark Boulet et al model 2021 on multi-level factors influence food behaviours and waste.

Co design workshops with food and nutrition experts from academic, retail, manufacturing and behaviour change disciplines focussing on interventions across the five settings Home, ELEC, Primary school, Secondary and Tertiary and, Retail.

Part B: Analyse the current "vegetable consumption" spend across all stakeholders and understand the current impact of this spend.

A desktop review of past and current vegetable programs and associated costs was complemented through consultations with FVC ecosystem of researchers, state/territory health promotion agencies, state government representatives, vegetable growers, grocery retailers and NGOs/NFP's who all provided input into the estimate of investment in initiatives that promote vegetable consumption.

All current known projects were summarised into the investment model to describe the "current state".

Build investment scenarios

An understanding of the potential benefits from interventions was developed by the foundation research reviews undertaken by CSIRO as outlined in Module 1 of this report.

An understanding of where consumption occurred in Australia was updated via the baseline review as outlined in Module 2 of this report.

A workshop with key industry stakeholders considered the key variables influencing per capita consumption change informed the development of three scenarios (low, moderate, high).

International interventions and their associated costs were reviewed.

Estimates were made to take test-and-learn projects from research to state or national roll-out, estimates were made regarding the cost of impact in settings such as retail / consumer impact. These cost estimates informed the approach of costing national programs.

Further consideration was given to the importance of retail initiatives to underpin rapid national change in the home setting and the need to address the problem that vegetables are perceived as high cost. This led to the development of an optimal strategy that focused on value perception and education settings.

Based on detailed stakeholder engagement across a broad range of possible initiatives – the scenarios were converted into costs estimates across a 6 year (initial program to achieve 2030 Plus One Serve) plus a further ten years to give 16 years of forward estimates.

4. Module 4: Economic impact assessment

The refined baseline model was integrated with the developed intervention scenarios to project changes in vegetable consumption across demographics and settings. This involved quantitative analysis of consumption patterns and economic modelling to evaluate the net impact of the proposed interventions, including social benefits like employment and health improvements. The economic model was updated with the latest datasets, ensuring accurate assessment of the interventions' economic and social impacts over a projected timeline.

5. Consolidation Report

The findings and methodologies from all project phases were then compiled into a consolidated report. This document detailed the approaches taken, the interventions recommended, and provided a clear set of actions for both government and industry stakeholders to target for achieving the 2030 vegetable consumption goals. The report aimed to serve as a foundational document for future efforts to increase vegetable consumption in Australia.

Based on these critical stages, a series of key recommendations and conclusions were formulated, directing the necessary actions to be taken by the Federal Government, State Government, and industry stakeholders to successfully achieve the 2030 target.

6. Value Perception Study

Led by an expert working group, a study was conducted to investigate the value perception of vegetables among various consumer groups, with a particular focus on low-income populations. Strategies were developed to demonstrate vegetable accessibility for all, and findings were integrated into two key frameworks: behavioural and shopper messaging. The study evaluated the path to purchase, identifying and mapping out all appropriate trigger points to influence consumer choices effectively. *Note: the outcomes of this element are reported separately.*

Project scope & boundaries

Vegetable classification is generally determined by the edible portion of the plant. The Australian definition encompasses all starchy vegetables, including potatoes and legumes, while also including canned and frozen varieties. This definition excludes vegetable juices. Notably, potatoes prepared as hot chips or potato crisps are classified as discretionary foods rather than a serving of vegetables.

The understanding of what constitutes the usual daily intake of vegetables is pivotal in assessing adherence to dietary guidelines and nutritional targets set forth by health authorities. As delineated in the NHMRC 2013 Australian Dietary Guidelines, the term 'usual daily intake of vegetables' encompasses the amount of vegetable servings consumed on a typical day, as self-reported by individuals.

A ‘serve’ is precisely defined, offering a clear guideline for measurement:

- Half a cup of cooked vegetables or legumes.
- One cup of salad vegetables.
- Each serving equates to about 75 grams, providing a tangible metric for daily consumption.

Furthermore, the concept of 'adequate daily vegetable intake' is defined by whether an individual's consumption meets or exceeds the recommended minimum number of vegetable servings outlined in the dietary guidelines.

To ensure the accuracy of measurement within the overall project, it is necessary to clearly outline the key assumptions made in relation to inclusions and exclusions within the project of

For the purposes of promoting a healthy diet, our definition of vegetables includes not only traditional leafy greens, root vegetables, and legumes but also tomatoes and avocados (which can sometimes fall under the definition of a fruit) as well as vegetable juices. It excludes overly processed vegetable products (i.e. potato crisps or hot chips), or fermented and pickled vegetables. By focusing on whole, unprocessed vegetables, we encourage consumption patterns that will support optimal health outcomes.

The following articulates the breakdown of types, products and categories within our vegetable definition:

‘**Vegetable’ definition**: vegetables are usually classified on the basis of the part of a plant that is used for food. The Australian definition includes all starchy vegetables (including potatoes).

Table 1 Categories of vegetables included in the scope of this project

Rule	Product types	Vegetable categories
Included as part of project scope	• Fresh • Frozen • Dried / Dehydrated • Canned • Products where vegetables are a major component (e.g. high ‘serve’ claim Dari’s Soup On-the-Go, Campbell’s Real Soup, etc.)	• Categories defined as part of the original National Health Survey • Legumes • Tomatoes • Vegetable juice • Vegetable snacks (excl. those that are fried, processed)
Excluded from project scope	• Fermented • Pickled • Products where vegetables are a minor component (e.g. pizza, burgers, etc.)	• Processed potato products (e.g. chips, fries, etc.) • Vegetables oils or flours

Rules regarding product types

- All fresh, frozen, dried and canned vegetables are included within the definition of vegetables for this project.
- Fermented and pickled vegetables are not included in the definition of vegetables for this project.
- Products with a majority vegetable component are included in the definition, examples include soups, salads, and stir fries.

Rules regarding vegetable categories

- Legumes are considered as vegetables within this project for the following reasons:
    - They are included within the 2017-18 Australian National Health Survey (ABS, 2018), which forms the basis of the previous 2.4 serves per person per day baseline.
    - In the paper 'Customer Understanding and Culinary Use of Legumes in Australia', it is stated that "legumes have been included in both meat and alternatives, and the vegetable group in Australia, Nordic countries, United Kingdom, United States" (Figueira et al., 2019). This scientific categorisation means it is prudent to include legumes within the vegetable definition, as they are included in other scientific papers, such as those found in the literature review.
- Whilst technically a fruit, tomatoes are counted as a vegetable within the Eat for Health Australian vegetable and fruit guidelines (Eat for Health, 2024), which sets out the 5 serves per person per day of vegetables guidelines.
- Defined as snacks which have vegetables as a majority component will be included within the vegetable definition, however, this does exclude products that are fried or processed, even if they have vegetables as a majority component.
- Fresh potatoes are considered part of this vegetable definition, but processed potato products (e.g. fries and chips) are excluded.

Summary of key findings and recommendations

Module 1: Rapid review of global best practice

1. There was most evidence from systematic reviews of interventions in schools, at home or in mixed settings, and a lack of reviews that quantified the impact of interventions on vegetable intake in the retail setting, or through food service and food relief programs.

2. The average increase in vegetable consumption across all settings was + 0.12 serves per day, but up to + 0.4 serves achievable in the home or school setting. Based on the available evidence, achieving "Plus One Serve by 2030" will require a concentrated effort across multiple settings and intervention strategies.

Vegetable industry stakeholders should note that there is a relatively low number of studies that measure outcomes in the form serves of vegetables per day. Systematic reviews are required within settings to gather further evidence of the effectiveness of interventions in increasing vegetable intake.

Module 2: A proposed new methodology to quantify baseline vegetable consumption in Australia

3. A new vegetable consumption baseline methodology based on actual production, consumption and waste data was shown to be feasible.

4. The top-down (production minus waste) and bottom-up (purchasing minus waste) methods reconciled in a satisfactory way to provide confidence in the new-base calculations.

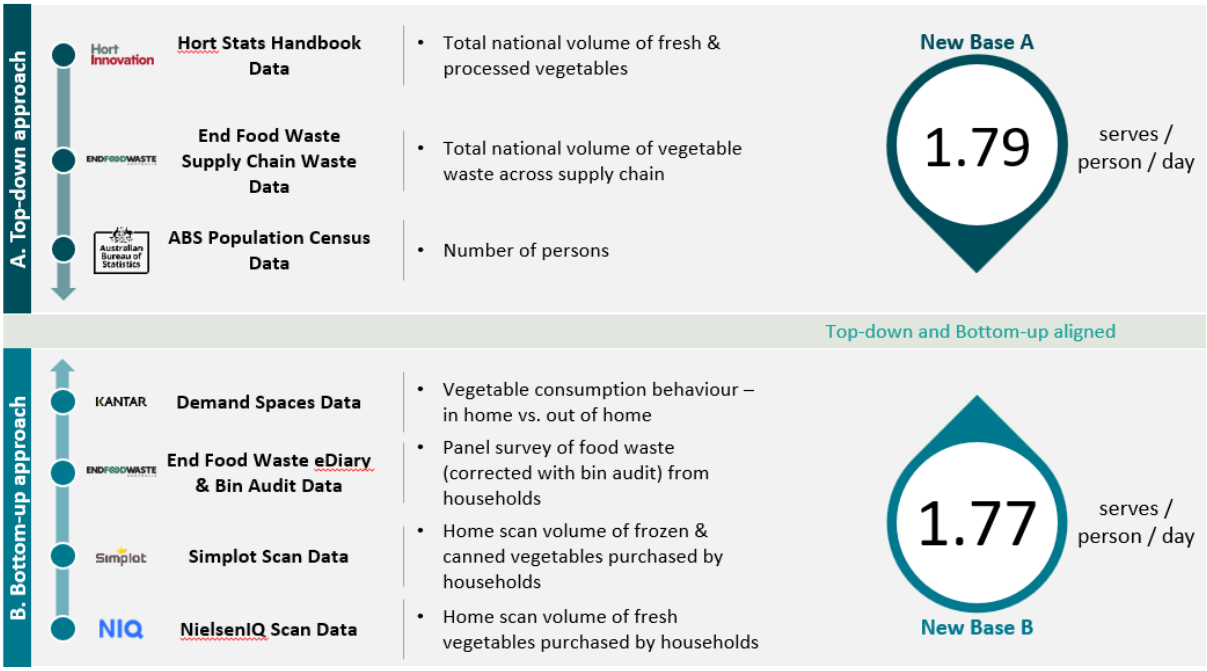

Figure 2 Reconciliation between top-down and bottom-up methods to approximate vegetable consumption

5. The new-base methodology found that the current consumption baseline was 1.8 serves per person per day (lower than the previous estimate of 2.4 serves per day). This new figure, along with a detailed breakdown into fresh and processed vegetables going to Retail and Food Services, formed part of the inputs of the Economic Impact Assessment via the Hi-Link model outlined in this report. It is recommended that the industry adopts this new methodology as its formal baseline of vegetable consumption.

6. It is possible to replicate the new baseline methodology quickly and easily e.g. annually - using data already available to the industry bodies. This would provide a consistent means of measuring changes in consumption levels towards 2030. This should account for positive impacts on vegetable consumption from the One Serve

program and changes to vegetable waste. More work is required on out-of-home settings (see separate recommendation).

7. Updating the baseline requires annual update of all datasets used in the top-down bottom-up modelling approach. To improve the current analysis, updated datasets must be provided in a granular (i.e. household-level) format where available. Additional desirable metrics such as monthly aggregates would also allow time-series analysis, which enables normalization of seasonality effects and isolate the genuine impact of interventions.

8. It is recommended the horticulture industry review its data requirements and agreements to include data for the new-base methodology.

9. Key elements of the One Serve program plan to focus on out-of-home settings. There are currently no data systems in place for out-of-home settings that can inform a granular baseline. It is recommended that industry considers further work as outlined below
    a. Finalising data models for educational, food service settings that provide a repeatable and cost-effective vegetable consumption baseline calculation, enabling regular updates to vegetable consumption data. This model would consider factors like canteen offerings, lunchbox waste, demographics, and seasonal variations.
    b. Expanding data access by partnering with existing organisations such as food service providers, catering companies, educational networks, and research institutions. Where gaps exist, designing surveys or new data collection methods to capture essential insights into consumption and waste patterns.
    c. Creating sector-specific data models for Early Learning, Primary, Secondary, Tertiary, food service sectors, incorporating geographic and economic factors. Integrate this data into the national database and reporting dashboard, aligning with insights from home and retail settings, and automate data transfer processes where possible.

There are several recommendations for industry relating to: the adoption of a new baseline methodology; the regular update of data sets; undertaking further ethnographic consumer research and updating waste data; leveraging partnerships and technology to measure vegetable intake and waste across all settings; and revising vegetable industry syndicated data needs for the new baseline approach.

Module 3: Plus One Serve Investment Scenarios

Part A: Behavioural intervention framework

10. The framework summarised below is recommended for the Plus One Serve initiative.

11. The framework is a robust tailored framework to guide interventions to increase veg consumption that through evaluation will positively contribute to the achievement of “Plus One Serve” by 2030.

12. Evidence consistently shows its success is how well the framework is used and the way that the interventions across all categories are curated, evaluated, evolved and consistently supported over time. In Melbourne it took 7 years of consistent interventions and support to establish a new lower base line of per water capita consumption – 100 litres less per day that remains 17 years later even with over 1 million more people, demonstrating generational change and stronger valuing of water in the community. It is the same for other programs we have been involved in road safety, smoking cessation, women’s activity rates, workplace safety, salmon consumption.

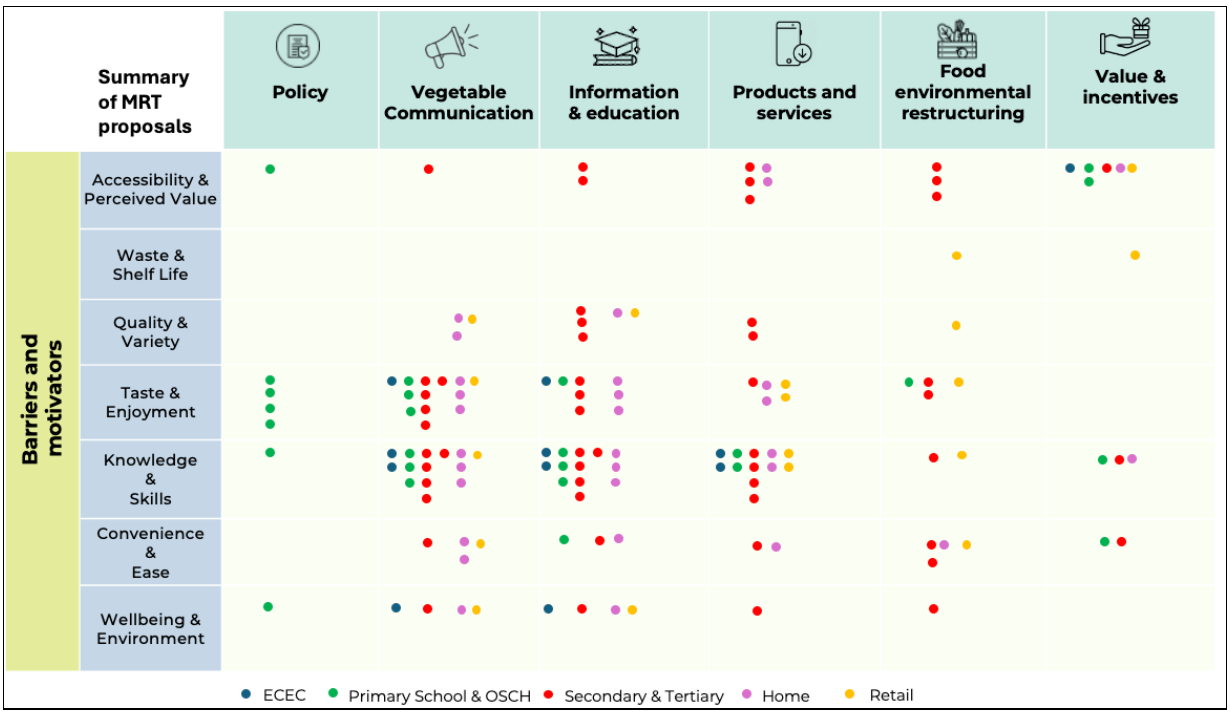

Figure 3 VG23005 'Plus One' Behavioural Intervention Framework

A top-down approach (evidence-based and expertly advised through a collaborative co-design process) has been taken to develop the national intervention framework. A test and learn approach is proposed for the Plus One Serve program, with successful interventions to be upscaled for national rollout.

The future investment scenarios (Part B) include a significant component of communication and marketing investment to drive awareness and on-going messaging for the National behaviour change campaign.

Part B: Future investment scenarios

13. An approximate 274 percent increase on current investment is estimated to be required to increase Australian vegetable consumption from an average 1.8 serves per person per day to 2.8 serves per person per day by 2030.
14. This study proposes that the most efficient way to achieve this is by prioritising investment in retail and the home setting where reach is close 90-95% of all Australians as well as growing investment in education settings.
15. Achieving Plus One Serve will require an estimated additional investment of $1.168b over a six-year period from 2025 to 2030.
16. Sustained changes to Australian's relationship with vegetables is proposed to start where food is purchased by addressing consumer misconceptions that vegetables are too expensive, might be wasted or are too difficult to prepare.
17. The key to success starts with generational change from the home through to children in education settings where healthy eating can be reinforced to build life-long vegetable eating habits.

The portfolio of projects modelled in the optimal scenario is a new combination of structural interventions e.g. initiatives to improve value perception in retail, and other behavioural change methods. In other words, this is a collaborative cross-sector national program with new approaches that have not been tried before.

A multi-layered co-investment model is needed to fund the national behaviour change programme - spanning government, industry and business. This investment will be in the form of policy change, restructuring of environments, and delivery of community-based programmes.

Whilst the value of investment is high, it is to be noted this is spread across sectors, stakeholders, initiatives and includes structural change. This scenario is modelled to deliver a significant return to industry, business and the community.

Critical to achieving Plus One Serve by 2030 is priority focus on investment in Retail and Home settings in years 1 to 3.

Module 4: Economic Impact Assessment

Impact modelling describes that by 2030 increasing vegetable consumption by one serve per person per day is represents a:

18. 56% increase in consumption compared to the modelled national baseline of 1.8 serves per person per day.

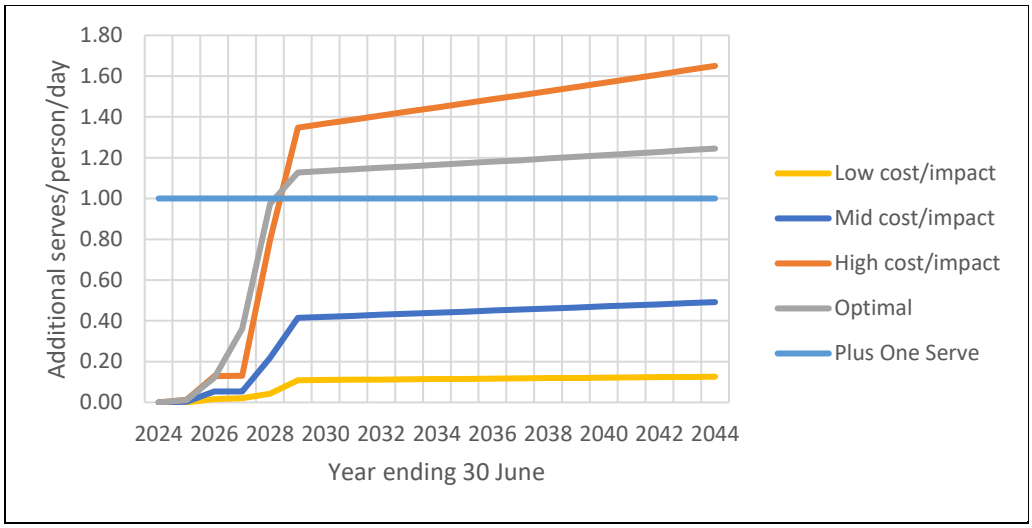

Figure 4 Additional serves per person per day from the baseline

19. $1.38 billion decrease in healthcare costs from reduced health risk associated with cardiovascular disease, cancer and type 2 diabetes.
20. $3.30 billion net supply chain economic benefit distributed across the vegetable growing regions and along the vegetable supply chain from growers to retailers.
    a. The farm/processing sector will generate the majority of benefit ($2.73 billion).
21. $12.30 return for every $1 invested.
22. 12,841 jobs added across vegetable production regions.

The modelling demonstrates that the target of adding a serve of vegetables to Australian diets by 2030 is feasible with high return on investment. However, it should be noted that the dietary change is significant and achieving the target intake requires national cross-sector collaboration and investment.

In closing:

VG23005 has successfully provided the launch pad for a national behaviour change program that will drive an increase in Australian vegetable consumption by one serve per person per day by 2030.

This project has gathered global evidence on vegetable intake interventions and their impact within settings. A new approach to measuring the national baseline has been developed, with the scenario modelling and optimal investment approach demonstrating that a national behaviour change program to increase vegetable consumption will deliver significant benefits to industry, the economy, and improve the health and wellbeing of all Australians.

Next Steps

There are **twenty-two findings** and recommendations outlined above and we commend these to the industry for noting and implementation as part of the consideration of the future **Plus One Serve of Vegetables by 2030** strategy.

1 A rapid overview of best practice interventions

Consolidating the evidence on the effectiveness of strategies to promote vegetable consumption in priority settings.

1.1 Introduction

Fruit and vegetables are an important component of a healthy diet, and adequate consumption is a marker of overall diet quality due to the association with higher nutrient intakes and reduced risk of chronic diseases. The World Health Organisation estimates that approximately 1.7 million annual deaths worldwide are associated with low fruit and vegetable consumption (World Health Organisation (WHO), 2024). In Australia, it is estimated that dietary risks were responsible for 5.4% of the burden of disease (in 2018), and more specifically, that 2.3% of all deaths were attributable to diets low in legumes, 1.3% to diets low in fruit and 1.2% to diets low in vegetables (Australian Institute of Health and Welfare (AIHW), 2021). Despite the well-established links to health and mortality, consumption of fruit and, in particular vegetables remain persistently low and below recommendations. In Australia, less than 5% of adults and children meet the recommendations for vegetables. Changing population dietary habits to any significant degree has proven to be challenging, but improving dietary habits will have tremendous health, social and economic benefits. Therefore, efforts towards improving dietary habits have continued. The World Health Organisation and many countries around the world (Food and Agriculture Organization of the United Nations (FAO), 2024) have food-based dietary guidelines that emphasise the importance of consuming vegetables as part of a healthy diet. Despite clarity in these guidelines, translating this information into effective behaviour change campaigns has been difficult. There have been social marketing campaigns such as the Go for 2&5 campaign in Australia and the 5-A-Day type programmes in Canada, Denmark, the USA and the UK, which have reportedly led to increased awareness, but have not increased consumption consistently or by a significant amount (Civic Creative, 2015, Rekhy and McConchie, 2014, Research., 2007). At a state-level in Australia, there are also government funded programmes for school children that promote vegetable consumption, for example, Munch & Move aimed at pre-school children and Crunch&Sip® aimed at primary school children. Some of these programs have demonstrated small, often statistically non-significant, increases in vegetable consumption but whether larger changes in consumption can be achieved, and sustained, in programs with broad reach remains unclear.

There has also been a lot of focus on improving vegetable consumption within research studies. Published research initiatives tend to be smaller in scale than social marketing or government endorsed programs but given the large numbers of studies published, there are many systematic reviews available synthesising findings from these primary research studies. Systematic reviews collate a body of evidence that fits a pre-specified eligibility criteria to answer a specific research question, using standardised methods that aim to minimise bias when summarising the evidence and drawing conclusions (Higgins et al., 2023). Previous systematic reviews have described effectiveness of interventions to increase vegetable consumption and intervention strategies that are associated with successfully changing behaviour, across different settings and population groups. Many overviews of systematic reviews ("umbrella reviews") are also available which further consolidate and summarise the findings of systematic reviews. Umbrella reviews suggest that settings-based interventions can have positive effects on dietary outcomes, including vegetable intake. These include schools (Wolfenden et al., 2021, O'Brien et al., 2021, Verdonschot et al., 2023), homes (Wolfenden et al., 2021) and workplaces (Schliemann and Woodside, 2019), or those using specific strategies such as digital delivery of interventions (Wolfenden et al., 2021), facilitating vegetable acceptance (Bell et al., 2021), or garden programs delivered across a range of settings (Skelton et al., 2019). However, many umbrella reviews report fruit and vegetable outcomes together (O'Brien et al., 2021, Wolfenden et al., 2021), making it difficult to ascertain an overview of the effectiveness of interventions to increase vegetable consumption.

A strength of systematic and umbrella reviews is the high-quality evidence synthesised in regard to a specific research question. However, their methodological rigour and process means they can take one to two years to complete (The Cohrane Collaboration, 2020). Rapid reviews are increasingly used to inform decision making and optimise investment, because by definition, they can be conducted more quickly to support the time-sensitive needs of decision makers. To ensure scientific rigour is maintained in rapid reviews, guidelines have been published by the Cochrane Collaboration to establish best-practice in rapid reviews of effectiveness. Using these guidelines, this rapid review aimed to summarise the findings of published review articles which included interventions to increase vegetable consumption, in isolation or in combination with other foods or lifestyle behaviours. Specifically, this review aimed to summarise the effectiveness of interventions in increasing vegetable intake across different priority settings. Findings from this review will be used to guide the interventions in the Plus One Serve by 2030.

1.2 Methods

1.2.1 Overview

The review was guided by recommendations for the conduct of rapid reviews from the Cochrane Handbook (Appendix 1A) (Garritty et al., 2024). A study protocol, including the study objective, search strategy, selection criteria and synthesis plan were specified a priori (Appendix 1B). The findings of the review are reported based on suggestions in the Preferred Reporting Items for Overviews of Reviews statement (PRIOR; Appendix 1C) (Gates et al., 2022). Experts were consulted at various stages of the review process to (i) set and refine the review question, eligibility criteria, and outcomes of interest; (ii) provide feedback on the search strategy to ensure it was fit for purpose; (iii) review the list of included reviews to identify potentially eligible reviews that were missed; and (iv) review and provide feedback on the conclusions of the review.

1.2.2 Information sources and search strategy

A literature search was conducted on 15 February 2024 across three databases: PubMed, Web of Science (core collection) and Cochrane Central. The search strategy was developed in consultation with an expert librarian using a modified PI(E)COCS framework (Population, Intervention / Exposure, Comparison, Outcome, Setting and Study Design; Table 2). The search strategy was tested in PubMed to confirm that relevant articles from preliminary searches were retrieved and adapted for use in other databases according to their phrase searching and truncation guidelines.

A combination of MeSH (medical subject headings) terms and free-text keywords were used to search for relevant settings (e.g., 'home', 'community', 'school', 'workplace'), outcomes of interest (e.g., 'vegetable intake', 'vegetable consumption', 'sales') and study designs (e.g., 'systematic review', 'meta-analysis'). The detailed search strategy is available in Appendix 1D. The reference lists of included reviews and relevant review articles were searched to capture any citations missed by electronic searches ('backward search'). In accordance with recommendations for the Cochrane rapid review methods (Garritty et al., 2024), eligibility criteria, including restrictions applied to the search were limited for topic refinement. As such, search parameters were limited to articles published in the English language since 2014, because those published in the past 10 years represent the contemporary evidence base and would have captured primary research conducted over the previous 30 years or so (Aromataris et al., 2015).

1.2.3 Review selection

Citations and abstracts of all retrieved records were imported to EndNote (X9) (Clarivate, 2022). Duplicate records were identified and removed, and the remaining citations imported to Covidence (Covidence, 2024). Records were assessed for eligibility against the PI(E)COCS criteria, initially screened based on their title and abstract; any records that were potentially eligible were advanced to full-text review. Both stages of screening were performed by two reviewers independently (from a team of four: PB, GH, AP, KML), and conflicts were resolved through discussion until a consensus was reached.

1.2.4 Risk of bias assessment of included reviews

The Risk of Bias In Systematic Reviews (ROBIS) tool (Whiting et al., 2016) was used to assess the risk of bias of each review article by (i) identifying bias with the review process; and (ii) judging the overall risk of bias in the review. First, the risk of bias was assessed across four domains: study eligibility criteria; identification and selection of studies; data collection and study appraisal; and synthesis and findings. The level of risk of bias associated within any of the domains was graded to categorise the overall risk of bias as low, high, or unclear. Risk of bias assessments were performed by one reviewer (PB) and judgements were verified by a second reviewer (AP).

Table 2 Eligibility criteria

Criteria	Inclusion	Exclusion
Population	Humans (including children and adults)	Infants (<2y) Animals Population sub-groups selected on the basis of pre-existing comorbidities (e.g. those with type 2 diabetes, hypertension or cancer); reviews focused on strategies that targeted the treatment or management of eating disorders (e.g. anorexia nervosa or bulimia), malnutrition or other diseases
Intervention / Exposure	Interventions that aimed to increase vegetable intake (in isolation or in combination with a healthy diet) • Interventions can be administered in physical settings or online (e-health) *Note:* can include vegetable juice	First introduction to vegetables (i.e., weaning studies for infants)
Comparator	No restrictions	
Outcome	Quantified measure of vegetable intake (e.g., serves, portions, or grams/day); or Purchase data, as a proxy for intake (for retail settings only) • Measures can be objective (e.g., intake via weighed food record; purchase via sales data) or self-reported measure (e.g., intake via food frequency questionnaire; purchase via purchase behaviour) *Note:* where reviews include both fruit & vegetable intake, data must be reported on vegetables separately to be eligible for inclusion	Hypothetical choice Consumption intentions Health outcomes (e.g., weight change, disease risk) Overall diet quality Attitudes (e.g., preference/liking), knowledge, skills, access
Setting	Early Childhood Education and Care Primary schools & out-of-school-hours care Secondary & tertiary education Home-based Retail food environments – e.g., supermarkets, grocery stores, canteens, cafeterias Workplace Foodservice – Institutional Foodservice – Commercial Aged Care – In home and/or facility Food Relief	Laboratories or other simulated contexts
Study design	Overviews of reviews ('umbrella' reviews) Systematic reviews with or without meta-analysis	Primary research articles Opinion or perspective pieces Narrative or scoping reviews Protocol papers

1.2.5 Data extraction and synthesis

A standardised data extraction template was created in Microsoft Excel® (Version 2022) and piloted on 10% of records by two reviewers (PB and GH) to ensure critical data were collected consistently and correctly. Following the piloting exercise, no changes to the data extraction template were required. Data from remaining records were extracted by one reviewer (PB) and verified for accuracy and completeness by a second reviewer (AP or KML). In accordance with recommendations for the Cochrane rapid review methods, data extraction was limited to the most important data fields relevant to address the review question.

The following information from the included reviews were collected: (i) Publication Details: first author's family name, year of publication; (ii) Review Characteristics: primary objective, inclusion criteria and search restrictions, synthesis method; (iii) Relevant outcomes: outcome measured and unit of measurement, outcome results. If multiple time points were reported, only the end of the intervention point was extracted; (iv); Study Conclusions: main conclusions as reported by authors. Where a review reported separate syntheses of the effects of different intervention strategies/settings/population groups, information describing the effects of each synthesis (referred to as "findings" from here on) was extracted.

The characteristics of included reviews were synthesised narratively. The findings of the reviews on intervention effectiveness were summarised and presented in tabular form. Some assumptions were made in summarising the results of the reviews to allow findings to be combined to report the effect of interventions on vegetable intake in serves per day. For reviews that reported vegetable intake in grams, results were converted to serves using a standard vegetable serve size of 75g (National Health and Medical Research Council., 2013). One review reported vegetable intake as 'times per week' (de Medeiros et al., 2022), these results were converted to serves assuming 1 time was equal to 1 serve. One review reported a summary result for interventions as a range, and the mid-point was used as the data point for this review (Hendrie et al., 2017).

1.2.6 Deviations from the study protocol

Some changes to the methods outlined in the pre-specified study protocol were necessary. Firstly, overviews of reviews ("umbrella" reviews) were planned for inclusion to capture all available (consolidated) evidence in the research area. Following the execution of the search strategy and study screening, umbrella reviews were excluded from further analysis. We did, however, examine the reference lists of eligible umbrella reviews (Bell et al., 2021, O'Brien et al., 2021, Schliemann and Woodside, 2019, Skelton et al., 2020, Verdonschot et al., 2023, Wolfenden et al., 2021) to cross-check for the inclusion of relevant review articles. No additional reviews were identified from this method. Secondly, review articles that focused on weight loss interventions were excluded during title/abstract screening. Finally, review articles that focused on minority groups were excluded during full-text-screening. One review article that met all other eligibility criteria was excluded on this basis (Hayba et al., 2020).

1.3 Results

The literature search resulted in a total of 823 records; no records were identified via other methods. After the removal of duplicates (n=247), a total of 572 abstracts were initially screened by title and abstract. One-hundred and sixty-three abstracts were eligible for full-text review. A total of 20 review articles met the eligibility criteria and were included in this rapid overview of reviews (Figure 5).

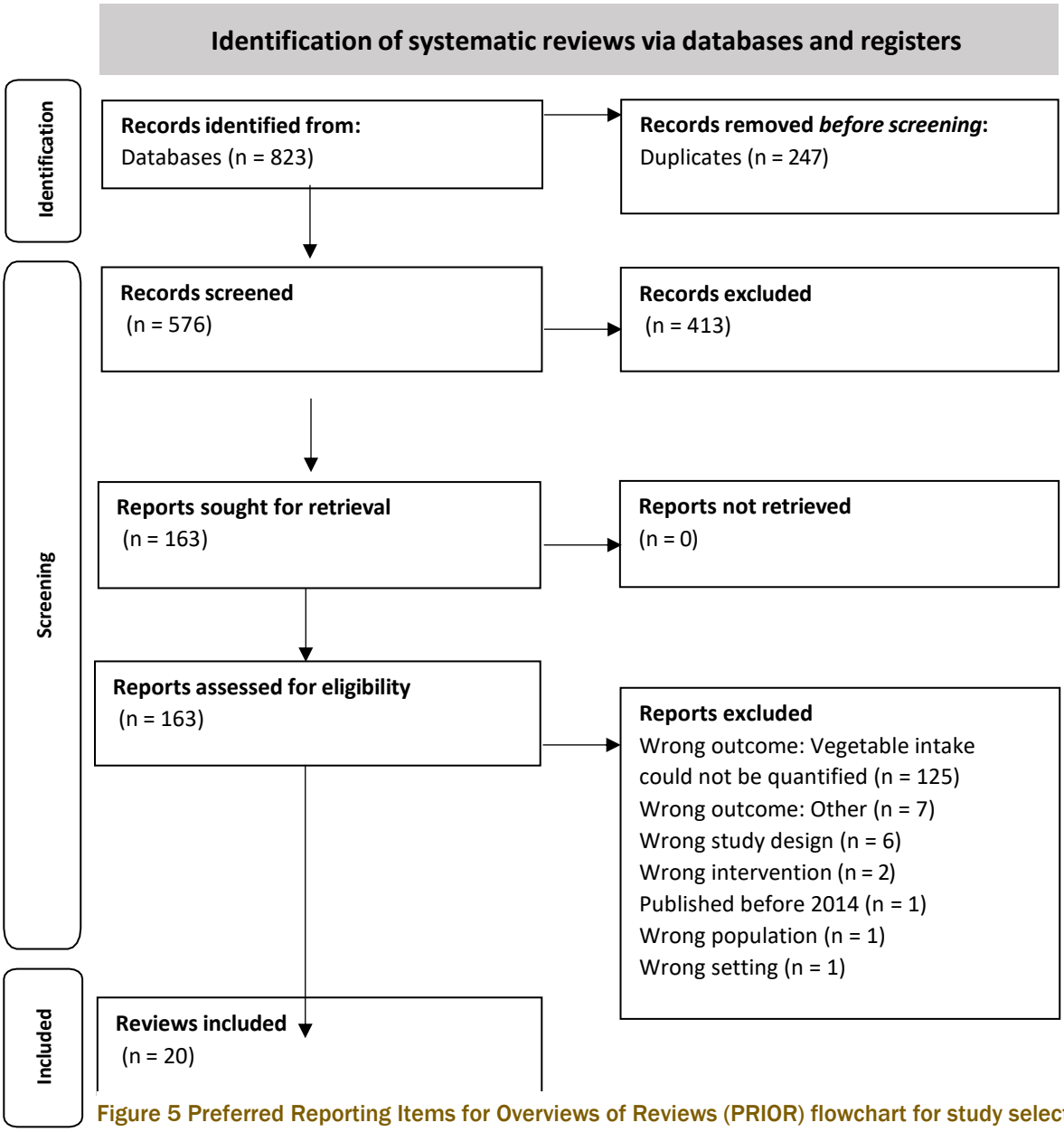

Figure 5 Preferred Reporting Items for Overviews of Reviews (PRIOR) flowchart for study selection

1.3.1 Review characteristics

The characteristics of the 20 included reviews are presented in Table 27 of Appendix 1G. Reviews were published between 2014 and 2024. With the exception of one review (Hendrie et al., 2017), reviewers synthesised the findings using meta-analyses. Most reviews focused on school-based settings (n=7 of 20; 30%) or community- / home-based settings (n=4, 20%). Early childhood education and care settings and workplaces were each covered by one review. There were no setting specific reviews focused on the retail, secondary school or tertiary education, food service, food relief or aged care settings that met the eligibility criteria for this rapid overview of reviews. The remaining seven reviews (Appleton et al., 2018, Broers et al., 2017, Diep et al., 2014, Nekitsing et al., 2018, Neves et al., 2020, Nour et al., 2016, Yang et al., 2023) were not setting specific, rather they focused on intervention strategies or population sub-groups across a range of settings.

The risk of bias of the included reviews was assessed using the ROBIS tool (Table 28 of Appendix 1G). Fourteen reviews (70%) were rated as having a low risk of bias, and the remainder were rated as high risk of bias (n= 6, 30%). The full appraisal, including how the reviews scored on each domain, is provided in Appendix 1E.

1.3.2 Review findings

The total number of primary studies included across review articles was 819 (ranged from 10 studies included in a review to 121 studies included in a review). About a third of these (n=274 of 819, 34%) reported findings on vegetable consumption or purchase (ranged from 4 studies reporting on vegetable intake in a review to 43 studies reporting on vegetables in a review). Most reviews (n=17 of 20, 85%) combined the results of studies and presented a pooled analysis of the main findings. Approximately two-thirds (n=11 of 17, 65%) reported a significant change (increase) in vegetable consumption or purchase among the interventions included (Table 28 of Appendix 1G).

Where reviews performed additional analyses, such as by setting, by intervention strategy, or population sub-groups, findings were extrapolated and presented in Appendix 1F. In total across the 20 review articles, there were 68 findings relevant to the aim of this rapid review, that reported on effectiveness of interventions in relation to vegetable intake. Just over half of the findings were reported as an effect size (e.g., standardised mean difference, Cohen's d, Hedges g; n=39, 57%), and the remainder reported findings as serves of vegetables (n=29, 43%).

Most findings reported on the change in vegetable intake from interventions in school-based or mixed-settings (n=20 each), followed by home-based settings (n=10). Fewer than 10 findings were reported for community-based settings (n=9), early childhood education centres (n=8) and workplaces (n=1; Figure 6).

Figure 2B illustrates the distribution of strategies assessed across the 20 reviews. Nutrition education was the most assessed strategy (n=15 findings), followed by provision (n=11), healthy lifestyle promotion (n=7), taste exposure (n=5) and use of theory (n=5). The remaining strategies that were assessed included different modes of delivery (n=4), lunchbox interventions (n=3), nudging (n=1) and use of partnerships (n=1). Mixed strategies, that is, where a range of different strategies were pooled in the analysis, comprised 12 of the 68 findings. Table 3 presents a summary of the effects of different interventions on vegetable consumption or purchase, by setting.

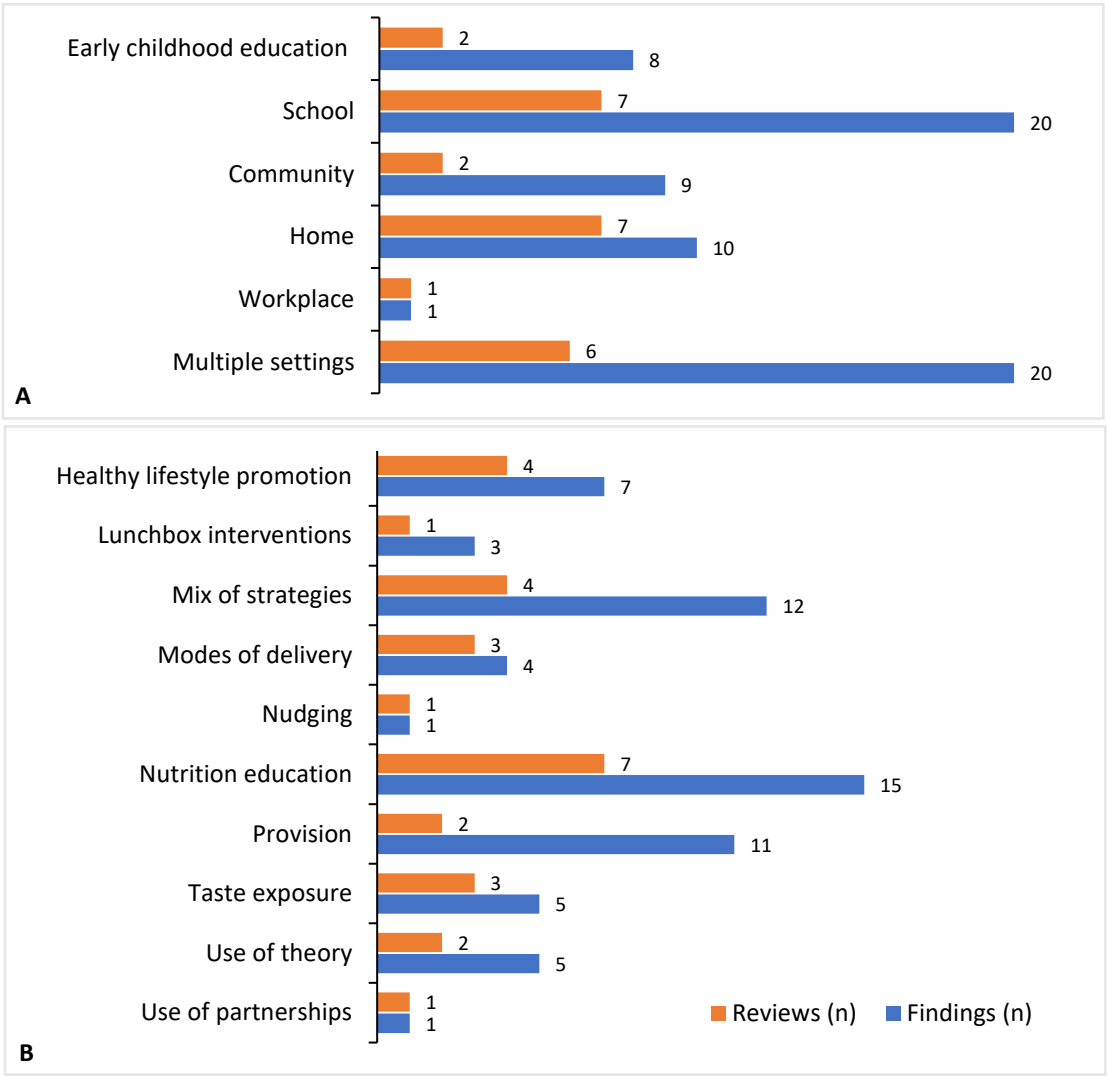

Figure 6 Number of findings reported across the reviews, by (A) setting, and (B) strategy

1.3.3 Early childhood education and care

Eight findings were reported across two reviews (Nekitsing et al., 2018, Yoong et al., 2023) for interventions conducted in early childhood education and care settings. Only one review reported findings in serves/day; this review found a change in vegetable consumption of +0.14 serves per day following healthy lifestyle promotion. The seven findings reported as effect sizes showed either no effect (n=5, 71%) or a small effect (n=2, 29%; Table 3).

1.3.4 School

Twenty findings were reported across seven reviews (Dabravolskaj et al., 2020, Nury et al., 2022, Pineda et al., 2021, Mingay et al., 2022, Micha et al., 2018, Vaughan et al., 2024, de Medeiros et al., 2022) for interventions conducted in school-based settings. Of the 18 findings that were reported in serves/day, the change in vegetable consumption ranged between -0.09 to +0.42 serves per day (Mean +0.09 serves/day). Intervention strategies included nutrition education, vegetable provision, and healthy lifestyle promotion. The largest increase in vegetable consumption was observed in nutrition education interventions. The two findings reported as effect sizes showed either no effect (n=1, 50%) or a small effect (n=1, 50%; Table 3).

1.3.5 Community

Nine findings were reported across two reviews (Jabbari et al., 2024, Neves et al., 2020) for interventions conducted in community-based settings. Reviews included studies in university, municipality, and senior's centres as community-based settings. Of the two findings that were reported in serves/day, the change in vegetable consumption ranged between +0.11 and +0.15 serves per day (Mean +0.13 serves/day). Both findings related to the use of a mix of intervention strategies. The seven findings reported as effect sizes showed either no effect (n=5, 71%) or a small effect (n=2, 29%; Table 3).

1.3.6 Home

Ten findings were reported across seven reviews (Nekitsing et al., 2018, Touyz et al., 2018, Neves et al., 2020, Nour et al., 2016, Hendrie et al., 2017, Jabbari et al., 2024, Nathan et al., 2019) for interventions conducted in home-based settings. Of the four findings that were reported in serves per day, the change in vegetable consumption ranged between +0.15 and +0.38 serves per day (Mean +0.25 serves/day). Interventions included lunchbox interventions, digital interventions, and mixed strategies. The largest increase in vegetable consumption was observed for the use of mixed strategies. The six findings reported as effect sizes showed mixed effects (no effect, n=2 (33%); small effect, n=2 (33%); medium effect, n=2 (33%); Table 3).

1.3.7 Workplace

One review (Peñalvo et al., 2021) reported the effects of healthy lifestyle promotion in the workplace on vegetable consumption. No significant change in vegetable consumption was observed (+0.03 serves/day).

1.3.8 Mixed settings

Twenty findings were reported across six reviews (Nekitsing et al., 2018, Yang et al., 2023, Broers et al., 2017, Neves et al., 2020, Appleton et al., 2018, Diep et al., 2014) for interventions conducted across multiple settings. The three findings that were reported in serves per day, all measured the effect of taste exposure interventions; the change in vegetable consumption ranged between +0.12 and +0.16 serves per day (Mean +0.14 serves/day). The 17 findings reported as effect sizes mostly showed small (n=9, 53%) or no (n=5, 29%) effects, and three (18%) showed medium effects in Table 3.

Table 3 Summary of findings of effects on vegetable consumption by setting and intervention strategy

Serves/day	Setting Strategy	Findings (n)	Minimum	Average	Maximum
	Early childhood education	1	0.14	0.14	0.14
	Healthy lifestyle promotion	1	0.14	0.14	0.14
	School	18	-0.09	0.09	0.42
	Healthy lifestyle promotion	3	-0.02	0.13	0.28
	Nutrition education	4	0.08	0.21	0.42
	Provision	11	-0.09	0.04	0.30
	Community	2	0.11	0.13	0.15
	Mix of strategies	2	0.11	0.13	0.15
	Home	4	0.15	0.25	0.38
	Lunchbox intervention	2	0.18	0.23	0.28
	Mix of strategies	1	0.38	0.38	0.38
	Modes of delivery	1	0.15	0.15	0.15
	Workplace	1	0.03	0.03	0.03
	Healthy lifestyle promotion	1	0.03	0.03	0.03
	Mixed settings	3	0.12	0.14	0.16
	Taste exposure	3	0.12	0.14	0.16
	Setting Strategy	Findings (n)	No effect (n, (%))	Small effect (n, (%))	Medium effect

Effect size*	Early childhood education	7	5 (71%)	2 (29%)	0
	Healthy lifestyle promotion	2	1 (50%)	1 (50%)	0
	Nutrition education	2	2 (100%)	0	0
	Mix of strategies	1	0	1 (100%)	0
	Use of partnerships	2	2 (100%)	0	0
	School	2	1 (50%)	1 (50%)	0
	Nutrition education	1	0	1 (100%)	0
	Mix of strategies	1	1 (100%)	0	0
	Community	7	5 (71%)	2 (29%)	0
	Mix of strategies	2	1 (50%)	1 (50%)	0
	Modes of delivery	2	2 (100%)	0	0
	Nutrition education	1	0	1 (100%)	0
	Use of theory	2	2 (100%)	0	0
	Home	6	2 (33%)	2 (33%)	2 (33%)
	Lunchbox interventions	1	0	0	1 (100%)
	Nutrition education	2	1 (50%)	1 (50%)	0
	Mix of strategies	2	1 (50%)	0	1 (50%)
	Taste exposure	1	0	1 (100%)	0
	Workplace	0	-	-	-
	Mixed settings	17	5 (29%)	9 (53%)	3 (18%)
	Mix of strategies	3	0	3 (100%)	0
	Modes of delivery	1	0	0	1 (100%)
	Nudging	1	1 (100%)	0	0
	Nutrition education	6	0	6 (100%)	0
	Taste exposure	1	0	0	1 (100%)
	Use of theory	5	4 (80%)	0	1 (20%)

Note: *, effect size reported in the review articles has been interpreted in accordance with cut-points suggested by Andrade, 2020 (Andrade, 2020). 'No effect', standardised mean difference < 0.2; 'small effect', SMD 0.2 to <0.5; 'medium effect', 0.5 to <0.8; and 'large effect', >0.8. The interpretation of effect size may differ from that reported by review authors.

1.4 Discussion

This overview of reviews was guided by the Cochrane rapid review guidelines and aimed to summarise the published evidence on the effectiveness of interventions to increase vegetable intake across a range of priority settings, including early childhood education and care; school and tertiary education; home; workplace; aged care; retail food environments; food service; and food relief. Twenty reviews met the eligibility criteria and were included in this rapid review.

Most of these reviews described the effectiveness of interventions in the school or home setting. There were fewer reviews from the early childhood education and care and workplace settings. Notably, the effect of interventions in the food retail sector, food service and food relief settings have not been reported in systematic reviews that met the eligibility criteria for this rapid review. Key criteria which limited the inclusion of review articles in this overview of reviews was the objective reporting of vegetable intake, separate from fruit. The retail setting is arguably a key setting of influence in terms of food purchasing and hence dietary intake. Households purchase nearly all their food within the retail setting (The Food Industry Association, 2013), and in Australia two-thirds of food purchases are from supermarkets (Peeters A, 2018).

Supermarkets have significant reach, and through the products they have for sale, their price and promotion they can influence purchasing patterns, and in turn eating habits. Determining the impact of interventions in the retail setting to increase vegetable intake, and others without a strong evidence-base, could be the focus of future systematic literature reviews.

Almost all the review articles included in the rapid review conducted meta-analysis to summarise the effectiveness of interventions on vegetable intake. Some reviews reported both overall ('main') findings, and findings by different sub-groups, either by population or strategy type. For this review, findings were grouped by their unit of measurement, as effect size (n=39 findings) or serves of vegetables (n=29 findings). Across the different settings, the average change in vegetable consumption was +0.12 serves per day (range -0.09 to +0.42). By setting, the largest increase in vegetable consumption was reported for interventions conducted in the school setting (+0.42 serves per day), followed by the home setting (+0.38 serves per day). Almost half the findings of effect size suggested no effect on vegetable intake (46%), 41% suggested a small effect and 13% a medium effect. Higher effect sizes were more common in reviews of multiple settings (71% of findings showed small-medium effects) and the home setting (67% of findings showed small-medium effects). While the impact of interventions resulted in an increase of +0.12 serves per day, and up to +0.42 serves at best, it is possible that interventions are additive to some extent and those delivered at school can complement efforts at home and in the retail sector for example. However, this is an assumption that is difficult to evaluate from the research findings here, although, interventions across multiple settings were more likely to report higher effect sizes so this is worth exploring further.

This rapid review followed the Cochrane rapid review methods and reported findings consistent with the PRIOR reporting guidelines. The search strategy was developed in collaboration with an experienced librarian and reviewed by experts. The search was focused, in terms of impact on vegetable intake separate to fruit, but broad in nature to cover a range of settings in which vegetables are consumed by different population groups. All screening processes were conducted by two reviewers independently, and data were extracted by one reviewer but checked by a second for all articles. Despite its strengths, some limitations to this review must be acknowledged. Across the studies included in the reviews, different measurement methods were used to determine consumption (e.g., servings, grams, pieces, cups, portions, times, percentage consumption, selection).

Serve size was not always defined in reviews, and likely differed between reviews, based on where they were published (Bucher et al., 2017). It was also difficult to synthesise the findings from all reviews included due to the different reporting metrics used in the articles. Findings reported as effect size and serves consumed were not combined. With additional time this could be possible and would strengthen the evidence around the increase in vegetable consumption in serves per day as a result of investment in interventions. While this was deemed out of scope for this review, it would be useful information to inform future nutrition interventions. Publication bias, i.e., failure to publish results of a study on the basis of the direction or strength of study findings, cannot be ruled out. Therefore, findings of this review may over-emphasise the effect of interventions on changing vegetable consumption. It is also possible that some reviews meeting our eligibility criteria were not captured from our search strategy.

1.5 Recommendations

There is a significant focus on improving the healthiness of diets in research and as such, lots of research examining the effectiveness of a diverse range of nutrition initiatives delivered across the settings of interest. However, this body of evidence becomes smaller when we are specifically focused on increasing vegetable consumption and require vegetable intake to be quantified, separate to fruit.

Key recommendations focus on building a stronger evidence base to gain a deeper understanding of the effectiveness of past interventions to increase vegetable intake which will help to inform the development of new interventions and investments.

1. Evaluate primary research studies in the school and home settings: Overviews of reviews are limited to the findings of published reviews – that is, overviews of reviews can only report on what other researchers have investigated and published. They do not account for potential omissions or overlap of original studies and may not include the latest evidence from primary studies that have not yet been included in published reviews. From an overview of reviews, it is also not possible to determine which specific intervention strategies are likely to be the most effective within each setting.
    a. We recommend that systematic reviews, with meta-analysis if possible, be conducted to investigate the effectiveness of interventions at increasing vegetable consumption in the school setting and in the home setting be conducted. Further work is also needed to understand the intervention features and behaviour change strategies associated successfully increasing vegetable intake in the school and home settings.
    b. If meta-analysis to summarise effectiveness is not possible, then changes in vegetable should still be quantified in an alternative way, such as percentage change from baseline.
    c. Reviews should also extract all timepoints reported in the primary studies so that the longer-term impacts on habitual intake can be explored. This is particularly important in the context of achieving sustained behaviour change.
2. Evaluate evidence in the retail sector, with a focus on supermarkets / grocery stores: More than ten reviews investigating the impact of intervention strategies in retail environments on the purchase of vegetables were retrieved from our search. However, no reviews were eligible for inclusion in this overview of reviews because vegetable sales were not quantified or were combined with other sales data (such as 'healthy food purchases' or 'fruits and vegetables').
    a. We recommend that a systematic review, with meta-analysis if possible, be conducted to investigate the effectiveness of interventions and strategies in supermarkets on changing vegetable sales.
3. Build evidence for those setting when there is currently limited or no reviews: Priority settings with a limited evidence base were ECEC and the workplace – only one review for each setting which quantified vegetable intake. Other settings that did not return any published reviews were food service and food relief programs, tertiary education, and aged care. However, effects of interventions in tertiary education (university) and aged care (seniors centre) were reported in reviews of community-based settings.

We recommend that systematic reviews be conducted to investigate the effectiveness of interventions and strategies aimed at increasing vegetable intake in these settings.

1.6 Conclusion

There was most evidence from systematic reviews of interventions in schools, at home or in mixed settings, and a lack of reviews that quantified the impact of interventions on vegetable intake in the retail setting, or through food service and food relief programs.

The average increase in vegetable consumption across all settings was + 0.12 serves per day, but up to + 0.4 serves achievable in the home or school setting. Based on the available evidence, achieving Plus One Serve by 2030 will require a concentrated effort across multiple settings and intervention strategies.

2 A review and update of the national baseline for vegetable consumption

2.1 Introduction

Current baseline of vegetable consumption in Australia

The Diet Report - Australian Institute of Health and Welfare (AIHW, 2022) reported that the average consumption of vegetables was 2.4 serves per day (serve = 75 grams) among persons 18 years or older. Incorporating estimates of consumption in children (aged 2-17) reduced this baseline slightly to 2.3 serves per person per day (ABS National Health Survey, 2022).

In either case, this figure falls significantly short of the five (5) serves per day guideline recommended by the 2013 Australian Dietary Guidelines issued by the National Health and Medical Research Council (NHMRC, 2013).

Limitations to existing methodologies of assessing vegetable consumption

The existing baseline average vegetable consumption of 2.4 serves per day in Australia has been derived from multiple surveys, including the Australian National Health Survey (NHS) for the years 2011-12, 2017-18 and 2020-21, along with the Apparent Consumption of Selected Foodstuffs Survey from 2020-21. The NHS utilised an approach including survey design, sampling from a representative population excluding *very remote* areas, data collection through personal or parent/guardian interviews, and statistical analysis incorporating weighting and calibration to reflect the broader population.

One potential limitation to this approach is the reliance on self-assessment/interview methodology. Self-reported dietary intake data, such as those utilized in national health surveys including the National Health and Nutrition Examination Survey (NHANES) and similar studies, are subject to inherent limitations, notably with the risk that vegetable consumption is overreported.

Studies examining the accuracy of self-reported measures, for example Hebert et al. (2008) and Radimer et al. (1997), conclude significant discrepancies between reported and actual intake levels. These discrepancies underscore a social desirability bias, with participants prone to underestimating their fat intake while overestimating fruit and vegetable consumption when compared to more objective measures like 24-hour dietary recalls.

Research by Stubbs et al. (2014) indicates that subjects not only underreport food intake but also alter their actual consumption when they are aware of being monitored, contributing to a divergence between self-reported and actual dietary data. The extent of these reporting discrepancies has been quantified in various studies, showing variations ranging from 5% to 25% depending on the methodology employed (Stubbs et al., 2014). This variance emphasises the challenges and limitations of relying exclusively on self-reported dietary data for nutritional research and public health assessments.

This research highlights that integrating objective measurement methods into dietary intake assessments could significantly enhance accuracy, especially in capturing vegetable consumption patterns within both research and public health initiatives.

The current consumption methodology can also be prone to parameter change. Notably, the NHS 2020-21 iteration adapted its methodology in response to the COVID-19 pandemic by transitioning to online, self-completed forms, affecting comparability with previous surveys due to changes in response rates, survey parameters and potentially affecting sample representativeness.

Another significant limitation to the current approach is the inability to include a factor for vegetable waste, both inedible (vegetables discarded during meal preparation) and edible (food otherwise not consumed by humans). Not only does this imply that the current methodology understates actual vegetable consumption, it also does not factor in any potential reduction in food waste resulting from efforts to halve food waste in Australia by 2030 (FIAL, 2020).

2.2 Objectives

A proposed new methodology to quantify baseline vegetable consumption in Australia

As an outcome of the *Shifting the Dial* report 2022 - it was concluded by industry via the FVC that an update to the baseline methodology was needed. A new baseline methodology could provide several benefits.

- More accurately demonstrate the base and hence the scale of the problem of low vegetable consumption in Australia and its cost to the industry and community.
- Provide a better baseline for settings and hence measurement of success of future investment in interventions at the settings level including the impact of vegetable waste in the methodology.
- Provide more granularity and insights into consumption issues and hot spots within particular demographics or categories. This can inform interventions, communication and core research.
- For the first time include vegetable waste in the analysis and grow our understanding of waste in the sector
- Lower the cost of calculating the baseline and make it easier to update each year.

The proposed new methodology aims to move away from memory-based or estimation-based surveys (memory recall, dietary surveys, etc.) and places more emphasis on the use of objective supply / sales data (e.g. sales or home scan data). This will largely eliminate human influences on the process of data capture and provide consistency to the baseline measurement.

The new methodology will also account for edible and inedible vegetable waste. This moves the methodology closer to a mass balance approach where inputs and outputs can mostly be accounted for.

A 'top-down/bottom-up' approach would be utilised, where total vegetable supply and waste at the national level is translated into number of serves per person per day (top-down). Separately, home scan and e-diary/bin-audit data will validate this result by quantifying consumption for a large number of surveyed households (10,000) and normalising for the Australian population (bottom-up).

Where data is available, the bottom-up approach will provide granularity to the existing baseline. This includes the ability to examine consumption by various geographic, demographic and economic factors.

2.3 Method

2.3.1 Defining the scope

The updated baseline aims to understand vegetable consumption by 'setting' according to the descriptions established by industry via the FVC. A settings approach to health promotion means addressing the contexts within which people live, work, and play and making these the object of inquiry and intervention as well as the needs and capacities of people to be found in different settings.

Table 4 Definition of the ten (10) settings of vegetable consumption (FVC)

	Setting	Definition
Horizon One	**Early Learning**	Places where young children receive educational and care services before entering formal schooling. For example, preschools, daycares, ELCs, family-run daycare). Demographic typically incl. children under 5 years old
	Primary School & OSCH	Encompasses the setting where primary school students attend classes during regular school hours and participate in organised care programs outside of school hours, such as before and after-school care. Demographic typically incl. children between 5 and 13 years old
	Secondary School & Tertiary	Encompasses secondary schools where teenagers receive formal education. The tertiary setting includes colleges and universities where students pursue higher education after secondary school. Demographic typically incl. children between 13 and 17 years old then then adults 18+
	Home	The setting where individuals and families prepare and consume food within the confines of their private dwelling. Home food consumption includes meals cooked and eaten at home.
	Retail	A place of business in which vegetables are primarily sold directly to an end-user consumer. Includes supermarkets, green grocers.
Horizon Two	**Workplaces**	Any or all of the places where individuals perform assign work tasks by an employer - this includes an office, factory, construction site, workshop or home office
	Foodservice – Institutional	A business or other entity that provides food and beverages to a specific group of individuals for consumption outside of the home. For example, a hospital dining service, defence catering, mining, airline catering
	Foodservice – Commercial	A business or other entity that provides food and beverages for consumption outside of the home - for example restaurants, pubs, QSR, food trucks, cafes
	Aged care in home and/or facility	A person aged 65 or over that resides in non-private dwellings provide communal or short-term accommodation - such as an aged care facility. This cohort includes those aged 65+ who reside by themselves or with a spouse or partner in a private dwelling.
	Food relief	Relief is a response by an organisation (including charities and government) for those in acute need but is also used to meet the needs of people facing chronic food insecurity. For example, FoodBank, OZHarvest, FairShare, SecondBite.

The ten identified settings (as prioritised by the FVC) can broadly be categorised as channel of vegetable supply (e.g. Retail purchases, donations from and to Food Relief programs), location of vegetable consumption (e.g. at Home, in School). It should be noted that these settings were designed with vegetable consumption interventions in mind. As a result, they are not mutually exclusive. For example, consumption within foodservice/institutional settings overlaps with workplaces and aged care, whilst food relief overlaps with all education-based settings.

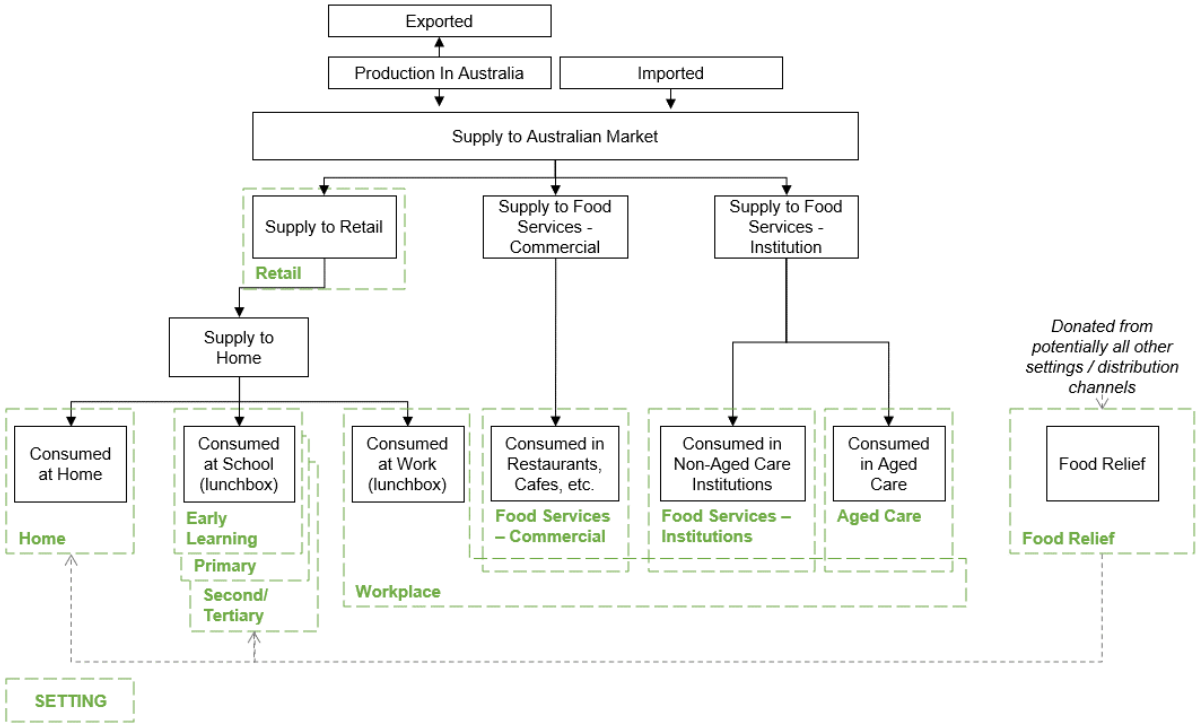

Figure 7 Mapping of settings against vegetable supply chain

Combining settings into retail and food service

While the *ten settings* approach provides a holistic framework for understanding vegetable consumption and intervention design, there is currently not enough data available to allow direct calculations of consumption baselines for most of the out-of-home settings.

Therefore, for the estimation of top-down vegetable consumption segmentation of the vegetable supply chain has been applied into two mutually exclusive groups: Retail and Food Service. This method follows the approach taken by Hort Innovation (Hort Stats Handbook, 2023).

'Retail' refers to all vegetables being sold through retail channels (supermarkets, greengrocers, etc.), which will eventually be purchased by households and to some extent restaurants, cafes, etc. Vegetables supplied to this channel will primarily be prepared at home and mainly consumed in the Home setting. This also includes lunchboxes prepared at home and consumed in other settings such as Workplace or School.

'Food Service' is a catch-all channel comprising of vegetables supplied to institutions, restaurants, hospitality industries, etc. It covers Food Service – Institution, Food Service – Commercial, Aged Care and partially covers Workplace.

The Food Relief Setting is assumed to be implicitly covered under this framework – as it is a channel which purchases or receives donations from other Settings and provides vegetables in the form of donation to shelters or households.

With vegetable supply, vegetable waste and total population data available at the national level, this framework can provide a top-down estimation of vegetable consumption.

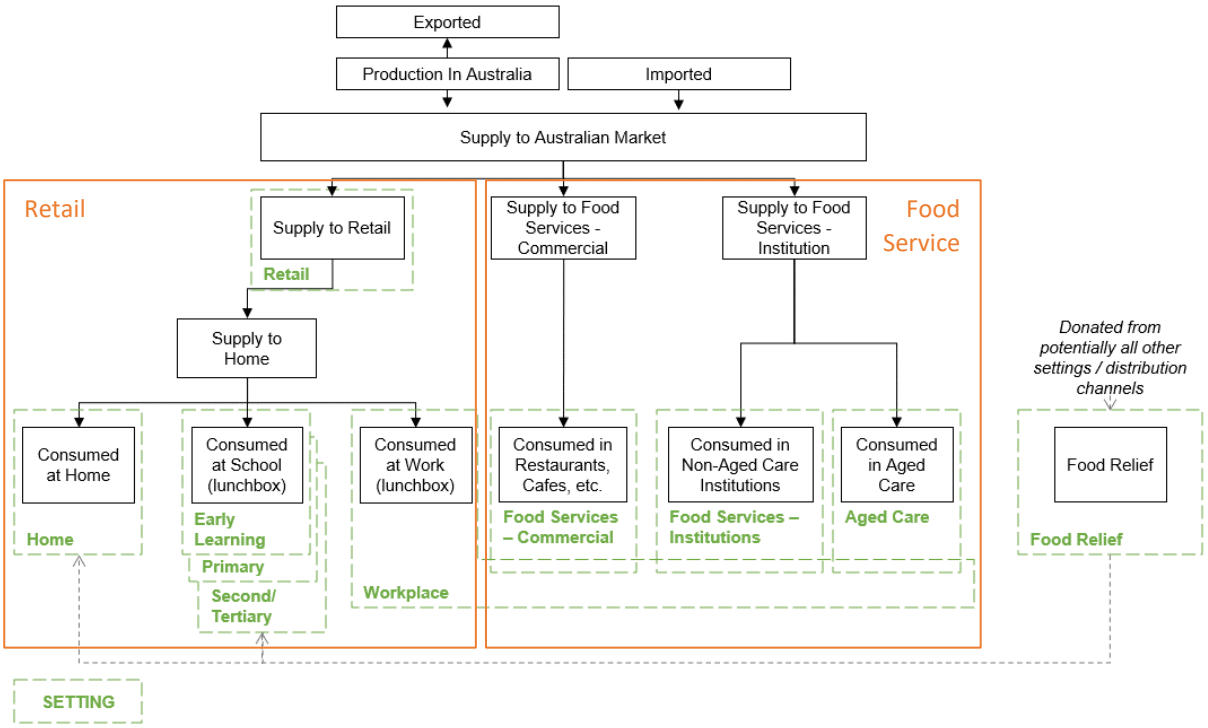

Figure 8 Simplified value chain of vegetable supply and consumption

At the time of this report, bottom-up data exists mainly for the "home" setting in the form of panel home scan data. As such, the scope of modelling in this module will be limited to a top-down estimation, plus a detailed bottom-up model for food consumed in the Home setting (also includes lunchboxes which are prepared at home but consumed later at school or at work).

3.2.2 Our overall approach

The proposed new method is based on several empirical datasets to estimate vegetable supply and consumption net of waste, both in-home and out-of-home, with a particular focus on refining accuracy beyond the limitations of self-reported data.

The objective was to estimate consumption of vegetables net of waste in Australia using two methods, **top-down** from supply data and **bottom-up** using consumer data. Both methods provide a theoretical maximum consumption because we can understand the total tonnes of vegetables provided to the Australian market.

Having understood the maximum consumption – the task was to adjust this for waste across the supply chain and also validate and nuance the analysis using retain/consumer data.

Top-down modelling

The primary source of data for the total vegetable supply in Australia was the Horticulture Statistics Handbook (Hort Innovation, 2023), which provided comprehensive figures on vegetable production adjusted for exports, imports, and processing (Horticulture Innovation Australia, 2023).

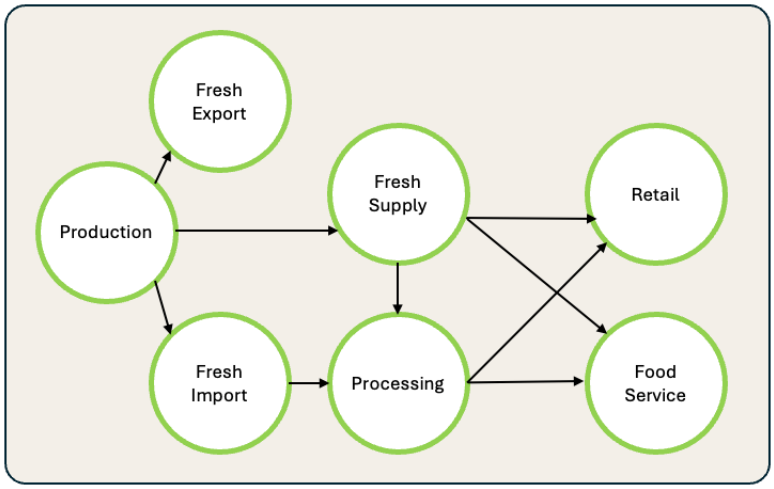

Figure 9 Reference framework for vegetable supply chain from Hort Innovation

These adjusted figures were further divided to delineate the supply directed towards in-home consumption (i.e. vegetables sold through Retail) and that destined for out-of-home consumption settings (i.e. vegetables supplied to Food Service).

To enhance the precision of our consumption estimates, food waste data from the Fight Food Waste Cooperative Research Centre (CRC) now known as *End Food Waste* was included in the methodology. This allowed for an aggregate, top-down understanding of per capita vegetable consumption, segmented into in-home and out-of-home consumption net of food waste (Fight Food Waste CRC, 2023).

Bottom-up modelling

For the in-home consumption segment, a more granular baseline was constructed using a combination of NielsenIQ Homescan and Simplot Homescan data, which contains scan data of fresh and processed (frozen, canned) vegetables purchased into the home. Additionally, food waste data from the Fight Food Waste CRC, validated through bin audit methodologies, was incorporated to ensure the accuracy of our consumption and waste estimates (Nielsen, 2023; Simplot, 2023; Fight Food Waste CRC, 2023). Notably, these data sets contain household characteristics including geographic, demographic and economic factors.

In contrast, the out-of-home consumption analysis relied on a top-down approach, leveraging Kantar data applied to the aggregate totals derived from the Horticulture Statistics Handbook. This method provided an overarching view of vegetable consumption in limited out-of-home settings due to the scarcity of granular data for these environments (Kantar, 2023).

Data model design

A dashboard has been developed on Power BI to serve as an interactive portal for accessing and understanding updated baseline consumption data, along with a standardised methodology to ensure the ease of future updates.

The bottom-up dataset, in particular, has been modelled utilised the ‘star schema’ approach. Star schema is a data modelling technique commonly used in data warehousing. In a star schema, data is organized into a central fact table surrounded by dimension tables, resembling a star shape when visualised.

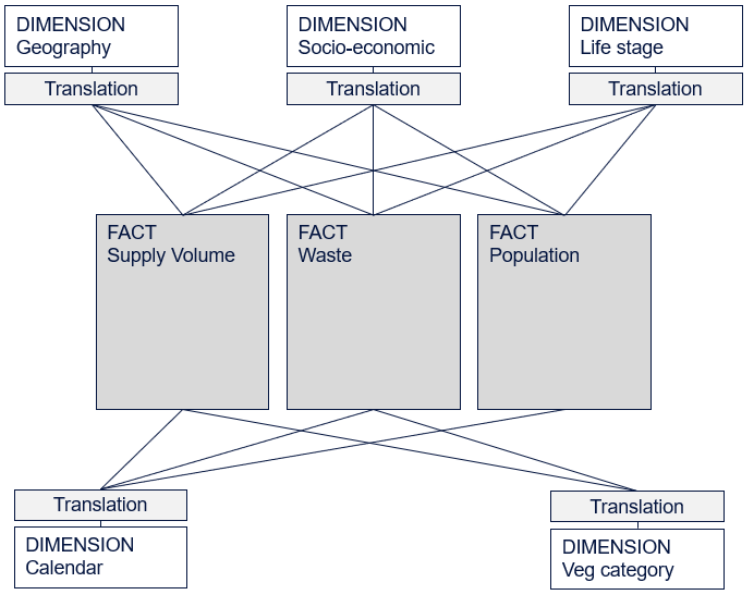

Figure 10 Conceptual representation of star schema data model

Under this schema, inputs such as vegetable supply, waste or population were considered 'Fact' tables. Fact tables contain numerical values such as volume (tonnage) or number of persons, which would form the basis of consumption calculations.

Each Fact table also contained a set of categorical values such as vegetable category, or socio-economic status of households being surveyed. These categorical values were 'Translated' into standard sets of 'Dimension' tables, providing a consistent set of queries, against which data such as volume or waste could be calculated.

This structure allows for efficient querying and analysis, as it simplifies complex relationships between data elements and enables faster retrieval of information. This is especially important for the bottom-up model where several large datasets (Nielsen IQ, Simplot and FFW) needed to be combined into a centralised model.

Data gaps and limitations

One major limiting factor for the current approach is availability of data, particularly in the bottom-up approach for the Home setting. As this method utilised a number of data sources, they often misaligned in terms of data coverage, data categories and data structure. This limits the ability to cross-tabulate between dimensions captured in these datasets and requires the use of simplifying assumptions or correcting scaling factors.

Discussions with FVC partners and engagement with industry stakeholders also revealed a lack in data, or even understanding of consumption patterns in out-of-home settings.

Development of a framework for establishing consumption baselines for out of home settings

In designing models for out-of-home settings, a systematic approach was undertaken, incorporating both desktop research and expert consultations. Initially, thorough desktop research was conducted to identify key statistical considerations and categorize various types of out-of-home settings catering to diverse demographics. This phase provided essential insights into demographic compositions, the landscape of stakeholders, and available data sources, laying a solid foundation for subsequent steps.

Following the desktop research phase, structured interviews were conducted with experts in the out-of-home sector. These interviews served as invaluable avenues for delving deeper into the dynamics of food provision models and data capture mechanisms within out-of-home settings. Experts offered perspectives on data availability, formats, and sourcing strategies, providing a nuanced understanding of the intricacies involved.

Insights garnered from expert interviews shed light on the diversity of food provision models present within out-of-home settings. From corporate procurement practices to community-driven contributions, the range of approaches underscored the complexity of the landscape. Discussions emphasized the importance of automation in data capture processes to streamline operations and enhance accuracy.

Furthermore, expert consultations played a crucial role in refining partner/data models for establishing baseline frameworks within out-of-home settings. Considerations regarding optimal methodologies for capturing consumption data, managing data responsibilities, and determining sample sizes were thoroughly examined. Additionally, discussions cantered on waste data capture mechanisms, aiming to ensure comprehensive coverage of waste management dynamics.

Structured approaches to data capture, including food diaries and audits, were explored during the consultation process. These methodologies were considered essential for obtaining detailed insights into consumption patterns and waste management practices within out-of-home settings.

The collaborative efforts between desktop research and expert consultations facilitated a comprehensive understanding of out-of-home settings, informing the development of robust baseline frameworks. Insights gleaned from the engagement process provided a solid foundation for further exploration and evidence-based interventions aimed at promoting healthier dietary habits across diverse out-of-home settings.

As the project progresses, the insights obtained will serve as guiding principles for subsequent phases, including pilot studies and nationwide implementations. By leveraging the knowledge gained through systematic research and expert input, the project aims to address the complexities of out-of-home settings and contribute to the advancement of public health initiatives.

2.4 Results

2.4.1 New Base A: Top-down modelling results

Estimating total vegetable supply to the Australian market

The top-down modelling approach was based on Hort Stats Handbook (HSH) data of fresh vegetables being produced and supplied to the Australian market. This approach includes both the fresh vegetable supply available for direct consumption and the total volume of vegetables diverted for processing into frozen, canned, and other preserved forms. To ensure accuracy and relevance, the model incorporated adjustments to include avocados, (which are nutritionally aligned with vegetables despite their botanical classification as fruits), excluded potatoes destined for processing into non-vegetable products like crisps, fries and mash and then further refinements were also made to account for the impact of both imported and exported vegetable volumes on the overall supply within the Australian market.

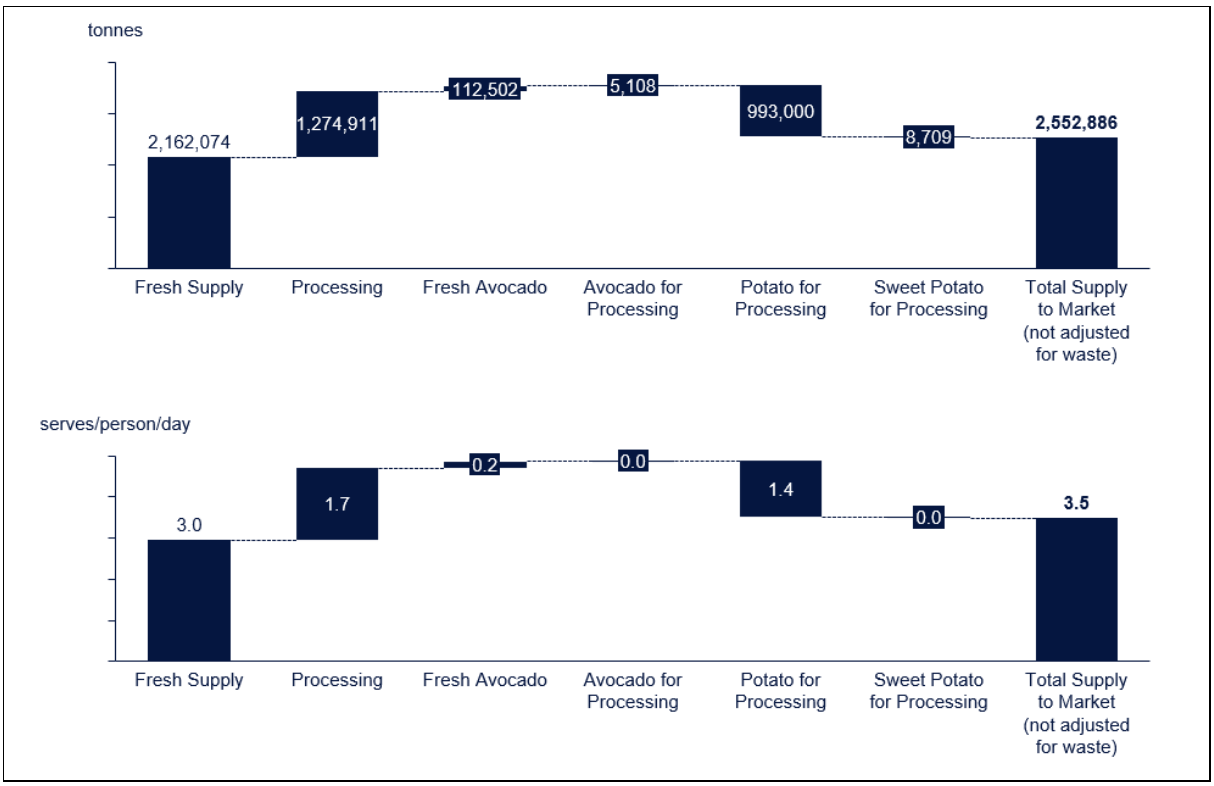

Figure 11 Volume of vegetables supplied to Australian market (2023) - excluding waste

Adjusting for 'upstream' vegetable waste

To refine the accuracy of the vegetable supply model, waste generated throughout the supply chain was also accounted for. This involved utilising data from the manufacturing, distribution, and wholesale-retail waste streams provided by FIAL 2021 data (2024 Technical Report – Horticulture Sector Action Plan) ensuring a comprehensive estimation of vegetable loss prior to consumer availability. This approach recognises that not all vegetables produced or imported ultimately reaches consumers' plates, and it aims to present a more precise reflection of actual vegetable consumption within the Australian market.

These manufacturing, distribution, and wholesale-retail waste streams comprise of total waste for both fruits and vegetables – totalling 835,557 tonnes across the three identified streams. Primary was excluded, as it measured the waste of vegetables and fruits not harvested at farms and it was assumed that this production was never presented to the market for consumption.

Table 5 Estimated upstream waste of fruits and vegetables in Australia (2021) across the supply chain (tonnes)

Supply chain stage	Total fruit and vegetable waste (t)	% supply chain waste (t)	Estimated vegetable waste (t)	Estimated vegetable waste (serves/person/day)
Primary	908,403	23.7%	395,628	0.54
Manufacturing	409,744	10.7%	178,452	**0.24**
Distribution	208,380	5.4%	90,754	**0.12**
Wholesale-retail	217,433	5.7%	94,697	**0.13**
Households	1,271,850	33.2%	553,917	0.76
Hospitality	757,992	19.8%	330,121	0.45
Institutions	57,353	1.5%	24,978	0.03
Total waste across supply chain	**3,831,155**	**100.0%**	**1,668,546**	**2.29**

The proportion of vegetables in these waste streams was assumed to be proportional to the amount found in total vegetables and fruits supplied to Australian market (Hort Stats Handbook data), at 43.6%.

Table 6 Components of total fruit and vegetable supply volume across the supply chain

Volume components	Volume (tonnes)	%
Total volume vegetables produced (inc. avocado, exc. processed potatoes)	2,552,886	43.6%
Total volume fruits produced (exc. avocados)	2,307,095	39.4%
Total volume potatoes processed	1,001,709	17.1%
Total veg and fruit supply in fresh and processed forms (adjusted for import export, exc. waste)	5,861,690	100%

This translated to 363,902 tonnes of vegetable waste (0.5 serves per person per day) occurring before vegetables were made available to the market (and therefore consumption in Australia).

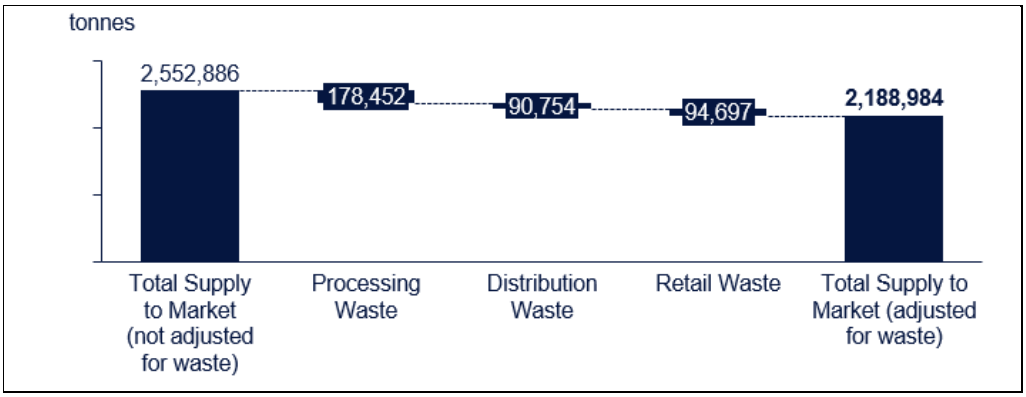

Figure 12 Volume (tonnes) of vegetables available to the Australian market (2023) - adjusted for waste

The supply noted in Figure 12 is equivalent to 3.0 serves per person per day being supplied to the Australian population (26,648,878 persons as of June 2023, ABS). This figure, however, only represents the supply level and does not account for potential losses due to factors such as consumer waste.

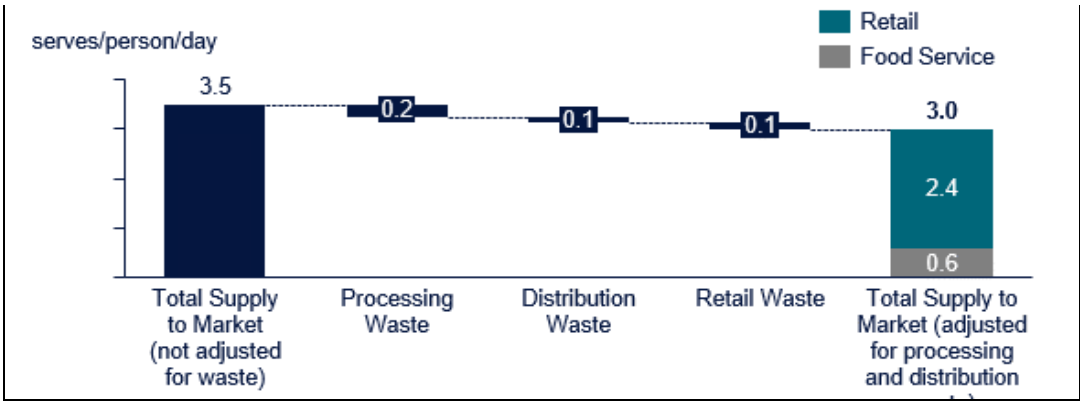

Figure 13 Volume (serves) of vegetables available to the Australiana market (2023) - adjusted for waste

Based on the Hort Stats Handbook volume of vegetables being supplied to Retail (79.7%) and Food Service (20.3%), it was estimated that 2.4 serves per person per day were supplied to Retail channels (i.e. supermarkets, greengrocers, convenience stores and others) and 0.6 serves were supplied to Food Service (institutions, restaurants, cafes, etc.).

Adjusting for 'downstream' vegetable waste

To account for consumption-related vegetable waste occurring downstream, a similar approach was used based on the FIAL 2021 data (2024 Technical Report – Horticulture Sector Action Plan) – where vegetable waste was assumed to be 43.6% of all fruit and vegetable waste across all stages of the supply chain.

Table 7 Estimated downstream waste of fruits and vegetables in Australia (2021) across the supply chain (tonnes)

Supply chain stage	Total fruit and vegetable waste (t)	% supply chain waste (t)	Estimated vegetable waste (t)	Estimated vegetable waste (serves/person/day)
Primary	908,403	23.7%	395,628	0.54
Manufacturing	409,744	10.7%	178,452	0.24
Distribution	208,380	5.4%	90,754	0.12
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Hospitality	757,992	19.8%	330,121	**0.45**
Institutions	57,353	1.5%	24,978	**0.03**
Total waste across supply chain	**3,831,155**	**100.0%**	**1,668,546**	**2.29**

Downstream vegetable waste across Household, Hospitality and Institutions totalled 1.24 serves/person/day. These three channels of the supply chain broadly reflect Food Service as presented in the simplified vegetable value chain (Figure 8).

Total estimated vegetable consumption from top-down approach

Using the above methodology, the total national consumption based on a Top-down approach was calculated to be **1.75** serves/person/day.

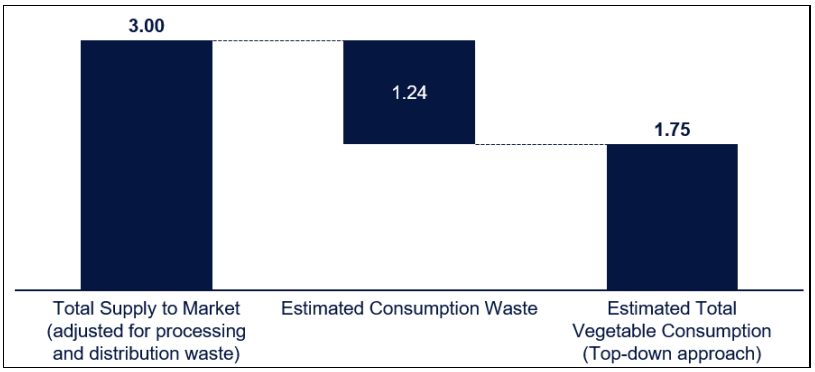


Figure 14 Estimated vegetable consumption in serves per person per day

Treatment of processed potatoes in the top-down approach

Processed potato such as fries and crisps play a huge role in the average Australian diet. As of 2023, 990,000 tonnes of potatoes are sent to be processed into these forms, equivalent to 1.36 serves per day supplied per person (Hort Innovation, 2023). Approximately 70% of this volume goes towards Food Service, predominantly as fries in restaurants. The remaining 30% are sold to the Retail channel and would largely be purchased into homes. Of this volume, approximately 69% (206kt) are processed into frozen potato products such as fries, mash, etc. (PPAA, 2019)

Whilst raw potatoes can be prepared as part of healthy diet as with any other root or hardy vegetables (e.g. baking, boiling, steaming, etc.), heavily processed (e.g. deep-fried potatoes or crisps) products lies outside of the ADG's recommendation for a healthy diet, and as such cannot be considered a vegetable in the consumption baseline. However, an argument could be made that lightly processed potato products, such as frozen cut chips with low amounts of added fat and sodium, are no different from raw potatoes being prepared (e.g. baked in oil) at home.

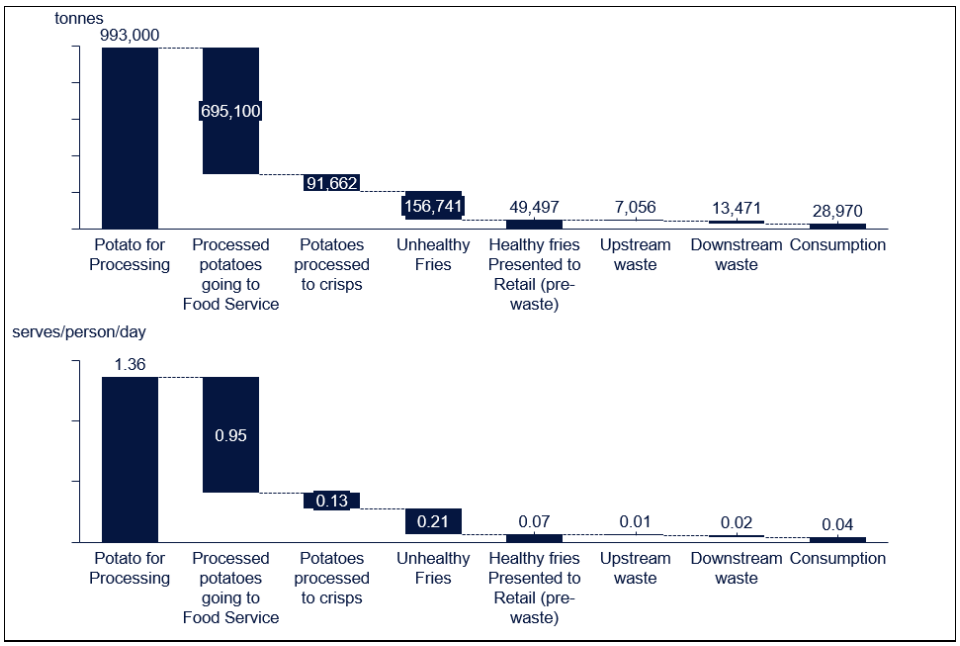


Figure 15 Consumption of processed potatoes in Australia (2023) - adjusted for waste

A stocktake of frozen potato products sold in major supermarkets suggested that approximately 24% of these contain relatively high potato content (above 90%) and relatively low total fat content (below 5g per 100g). Whilst this does not fully reflect actual purchase volume, it does provide directional indication of how much processed potatoes can contribute to vegetable consumption.

Assuming that upstream and downstream waste percentages for these products are proportional to waste figures in all processed vegetables, 'healthy' processed potatoes would add another 0.04 serves per person per day to the baseline, lifting it to **1.79** serves per person per day.

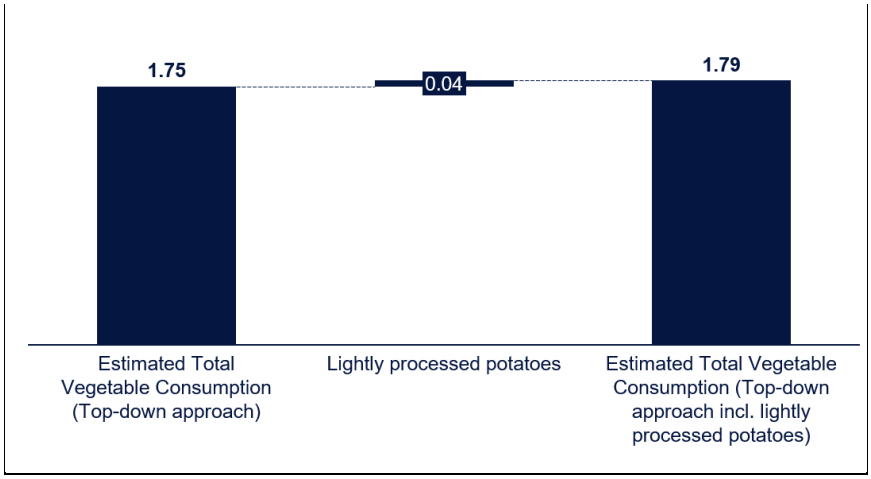


Figure 16 Estimated total vegetable consumption in serves per person per day (including some processed potatoes)

Segmenting consumption between Retail and Food Service

From here, the identified **1.79** serves of consumption could be further segmented to Retail and Food Service channels. This could be done by attributing 'Household' waste (0.76 serves) to the Retail channel and 'Hospitality', 'Institution' wastes (0.48 serves) to the Food Service channel (

Table 7).

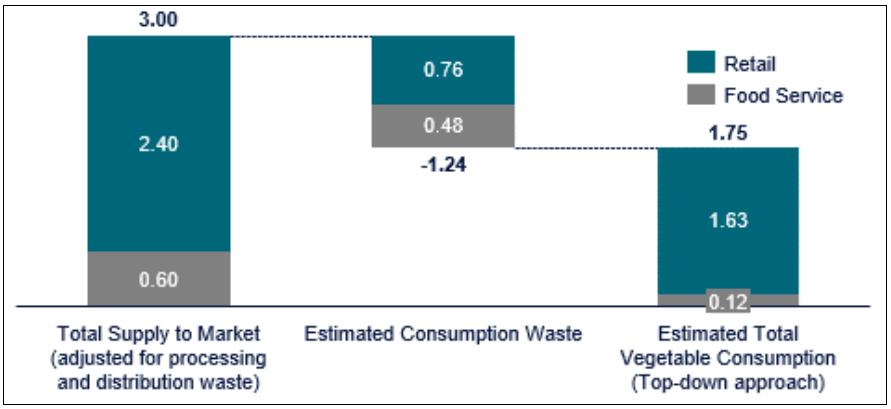


Figure 17 Estimated total vegetable consumption based on attribution of 'Households', 'Institutions' and 'Hospitality' waste streams

This breakdown of consumption between Retail and Food Service should be interpreted with caution – as it suggests 80% of vegetables served in Food Service are wasted. This reflects the limitation of the top-down modelling approach: whilst it could provide a maximum theoretical consumption at the national level, it may be limited in the ability to quantify consumption at a more granular level. This highlights the need for a supporting bottom-up model to validate top-down results.

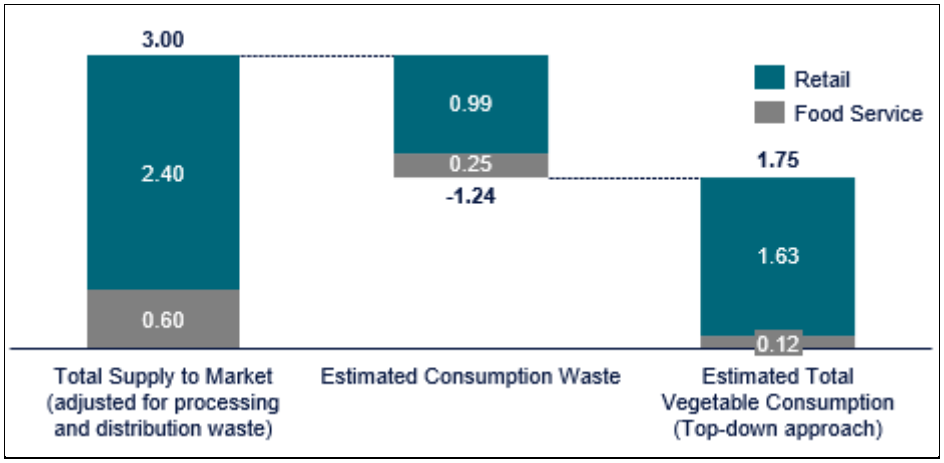


Figure 18 Estimated total vegetable consumption, assuming consumption waste is proportionate to supply between Retail and Food Service

For the final approach, a simplifying assumption was used to attribute consumption waste in proportion to the supply. This resulted in a total consumption of **1.63** serves in Retail and **0.12** serves in Food Service (Figure 18).

2.4.2 New Base B: Bottom-up results

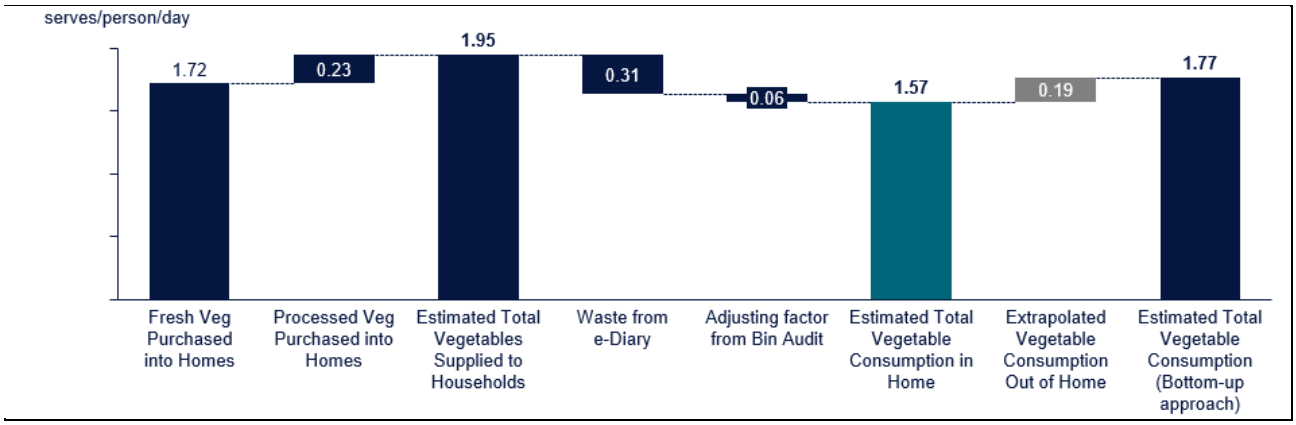


Figure 19 Estimated consumption of vegetables purchased into Australian homes (2023)

The Bottom-up approach quantifies vegetable consumption by combining a number of datasets each containing varying levels of detail regarding food categories and subcategories, as well as geographic, demographic, and economic factors. Namely:

- NielsenIQ Home Scan Data, which consist of a panel of 10,000 households recording their grocery purchases. This dataset contains all fresh vegetables purchased into households (including avocadoes and tomatoes)
- Simplot Home Scan Data, also a set of panel home scan data of 10,000 households. This dataset contains processed (frozen and canned) vegetables purchased into households, excluding all processed potatoes (fries, chips, etc.)
- FFW CRC Food Waste data, which contains e-diary data of food items (including both fresh and processed vegetables discarded) and accompanying correcting factor calculated from Bin Audit data

To ensure compatibility and facilitate a comprehensive analysis, these dimensions have been standardised across all datasets.

- Kantar Demand Spaces data surveyed a sample of 7,678 participants to understand their location of vegetable consumption (at home, at work, etc.). It was found that approximately 89% of vegetable consumption took place in the home (86% at home and 3% at someone else's home). From this figure, extrapolation resulted in a total vegetable consumption of **1.77** serves per person per day, across both home and out of home settings. **1.57** (89%) serves were consumed in home and **0.19** (11%) serves were consumed in out of home Settings.

Table 8 Location of vegetable consumption (Kantar)

Survey response	Setting	Weighted average
At home	Home	86%
At someone else's home		3%
At work/ office	Out of home	3%
At school/ university		1%
Out and about (park, street etc.)		1%
Travelling / commuting (car, bus etc.)		1%
At a restaurant / bar / coffee shop / food court etc.		5%
At a sports centre / gym		1%
At an entertainment venue (cinema, sports, shopping etc.)		1%
Other (please specify)		0%
Total		100%

These two approaches provided differing estimations of the volume of vegetables supplied from Retail to homes. Top-down approach suggested 2.4 serves being sold from Retail, presumably mostly to homes. The Bottom-up approach

estimated only 2.0 serves were purchased by households. The delta (0.4 serves) was likely sold to businesses, cafes, restaurants or not purchased as part of groceries (e.g. purchased while at work, etc.)

Whilst this result aligns with the Top-down approach, the proportion of consumption in-home vs. out-of-home differed. The Bottom-up approach suggested a higher home consumption (89%) compared to Top-down (79.7%).

2.4.3 *A closer look at consumption in the Home setting*

At a glance:

- Little variation in vegetable consumption between states (all approximately 1.6 serves)
- Between remoteness regions:
  - Households in major cities appear to purchase slightly more fresh vegetables compared to those in rural areas (1.74 vs. 1.69).
  - Processed vegetable data could not differentiate between remoteness regions, but existing literature implies that metro households consume less vegetables across categories compared to rural.
  - Rural households tend to discard more vegetables (0.49 serves) compared to metro (0.34).
- Between income groups:
  - Households with higher income purchase more and discard slightly more vegetables compared to lower income counterparts. All income groups primarily consume bulky and affordable vegetables such as potatoes, carrots, tomatoes and onions.
  - Low-income households (under AUD50k p.a.) appear to have consumed a slightly less diverse range of vegetables.
- Between life stage:
  - Life stage is a general term defining family or household characteristics, typically consisting of a combination of marital status, inclusion/exclusion of children, age, etc. Whilst there is a standard definition provided by ABS for the purpose of conducting the National Health Survey, each of the bottom-up datasets has their own definition and categorisation of life stage.
  - By best-aligning life stage categories between these datasets, it was found that vegetable consumption tends to scale with 'maturity' level of households. More specifically, 'Independent Singles' consume below 1 serve per day. Young adults in transitional stages may prioritise caloric density in food and, potentially due to price perception of vegetables, steer away from including vegetables as a main part of their diet.
- Between age groups:
  - Supply and waste data used in the bottom-up approach tracks the age of person making purchasing decision for the household. It was found that purchasers between 35-44 consume the least amount of vegetables (1.23) when compared to other age groups.
  - Purchasers under the age of 35 were much more likely to purchase processed vegetables compared to other age groups.
- Between sexes:
  - Fresh data did not record the sex of the person making purchasing decision in each household. Frozen vegetable data indicated that 83% of purchasers were female, whilst waste data brought this figure down to 40%

2.4.4 *Out-of-home settings baselines*

Over the course of completing the national baseline, it was established that there were gaps in understanding baselines in out-of-home settings, particularly in horizon 1 educational environments such as Early Learning, Primary and OSCH, and Secondary/Tertiary settings. In response, the next steps for extending the project involve identifying and addressing these data gaps.

Details and individual plans of each setting are provided in Appendix 2E. These outline the following for each out-of-home setting:

- Key statistics and background (on the setting),
- What should be considered as a representative sample and who are major providers of service/ support in area,
- Considerations in designing data framework /model for a baseline,
- Factors influencing vegetable consumption (in this setting and), and
- Potential partners for the settings' working group.

2.5 Conclusion / Recommendations

- A new vegetable consumption baseline methodology based on actual production, consumption and waste data was shown to be feasible. This method is also suitable for baseline modelling of other food categories such as fruits, nuts, etc.
- The top-down (production minus waste) and bottom-up (purchasing minus waste) methods reconciled in a satisfactory way to provide confidence in the new-base calculations.
- The new methodology found that the current consumption baseline was 1.8 serves per person per day (lower than the previous estimate of 2.4 serves per day). This new figure, along with a detailed breakdown into fresh and processed vegetables going to Retail and Food Services, formed part of the inputs of the Economic Impact Assessment via the Hi-Link model outlined in this report. It is recommended that the industry consider adopting this new methodology as its formal baseline of consumption.
- It is possible to replicate the new baseline methodology relatively quickly and easily on an annual basis using data already available to the industry bodies. This would provide a consistent means of measuring changes in consumption levels towards 2030. This needs to account both positive impacts on vegetable consumption from the One Serve program, as well as changes to vegetable waste. More work is required on out-of-home settings (see separate recommendation).
- Updating the baseline requires annual update of all datasets used in the top-down bottom-up modelling approach. To improve on the current analysis, it is required that updated datasets to be provided in a granular (i.e. household-level) format where available. Additional desirable metrics such as monthly aggregates would also allow time-series analysis, which enables normalization of seasonality effects and isolate the genuine impact of interventions. It is recommended that the industry review its data requirements and agreements to include the needs of the new-base method.
- Key elements of the One Serve program plan to focus on out-of-home settings. There currently are no data systems in place for out-of-home settings that can inform a granular baseline. It is recommended that industry considers further work as outlined below:
    - Finalising data models for educational, food service settings that provide a repeatable and cost-effective vegetable consumption baseline calculation, enabling regular updates to vegetable consumption data. This model would consider factors like canteen offerings, lunchbox waste, demographics, and seasonal variations.
    - Expanding data access by partnering with existing organisations such as food service providers, catering companies, educational networks, and research institutions. Where gaps exist, designing surveys or new data collection methods to capture essential insights into consumption and waste patterns.
    - Creating sector-specific data models for Early Learning, Primary, Secondary, Tertiary, food service sectors, incorporating geographic and economic factors. Integrate this data into the national database and reporting dashboard, aligning with insights from home and retail settings, and automate data transfer processes where possible.

3 Co-designing investment scenarios

3.1 Introduction

Module 3 of this report includes two key components.

A. The development of the 'Plus One Serve' Behavioural Intervention Framework
B. Development of the financial estimates that represent the future investment scenarios for Plus One Serve.

Behavioural Intervention Framework

The first part of Module 3 presents a new national **'Plus One Serve' Behavioural Intervention Framework** to guide the implementation and curation of interventions that will deliver plus one serve of vegetables by 2030 as modelled in Module 4.

It is designed to be used to classify interventions and how they address the barriers and motivators that impact consumption across the five settings – ELEC, Primary Schools and OSCH, Secondary Schools and Tertiary, Home and Retail, across all audience segments (SES, CALD, Regional and Remote) and snack/meal occasion.

The latter framing is important, too often programs are designed to overcome barriers and rather to leverage motivators. While sometimes they are mutually aligned emerging powerful motivators – environment and mental health through good gut health are often not sufficiently considered in the frameworks.

To achieve this the model predicts a rapid increase in consumption from 2027 onward and this will be largely driven by the interventions designed to impact the home and retail settings as identified in Module 2 base line analysis, where circa 90% of the uptake will occur.

This is also supported by the summary literature review conducted by CSIRO in Module 1 which found the Home setting to have the greatest up lift based on evidence.

This is not to say that interventions are or should be confined to one setting. As the co-design workshop highlighted and indeed many interventions currently in market impact across multiple settings e.g. Freshsnap, Stephanie Alexanders Kitchen Gardens. This is also reflected in the projects submitted for HN23001 MRT.

The new **'Plus One Serve' Behavioural Intervention Framework** is the outcome of evidence-based review of behavioural intervention frameworks, literature review of evidenced based interventions, co-design process with 49 of the nation's leading academics, retailers, manufacturers, behavioural scientists and behaviour change consultants, food consultants and marketers all informed by research and evidence from in market programs.

Plus One Serve Investment Scenarios

The second part of Module 3 describes the rationale and method for the development of investment scenarios with the goal of achieving Plus One Serve. The scenarios would inform impact modelling While not forecasts, these scenarios illustrate conceivable futures that may emerge over the short, medium and long-term. Scenarios are designed to be plausible, relevant and challenging to test a collaborative co-investment strategy and enable stakeholders to evaluate opportunities.

Scenarios and investment mixes detailed are based on proven evidence-based interventions and aim to address multiple barriers to vegetable consumption. The primary barriers to vegetable consumption as detailed in the Fruit & Vegetable Consortium's Shifting the Dial on Vegetable Consumption Report (2022) are, (but not limited to) lack of affordability, fear of waste, poor in-store quality and lack of skill and inspiration.

FVC partners have agreed that vegetable consumption can be addressed with programs that support vegetable consumption across multiple environments. This 'setting-based approach' describes points of opportunity to impact consumption in places where food decisions are made and food consumed, and includes schools, home, food service etc. Based on the available evidence, achieving plus one serve by 2030 will require a concentrated effort across multiple settings and intervention strategies.

In developing the investment scenarios the FVC collaborated with the full range of the FVC stakeholders via a co-design approach. Furthermore, the current investment effort was assessed in detail. This provided the platform for

the assessment of current state (which unfortunately is not leading to an increase in vegetable consumption) with the co-design providing a vision for an increase in investment that can drive Plus One Serve.

3.2 Objectives

- Re-visit the recommendations of the Shifting the Dial Report and align stakeholders on the barriers to increased consumption and a settings-based intervention approach.
- Understand the elements of a successful national change program and co-design frameworks for the Plus One Serve approach.
- Develop the Behavioural Intervention Framework for a national Plus One Serve program that describe future governance, project KPI's, project multi-criteria assessment, support functions especially communications and monitoring/evaluation.
- Analyse the current "vegetable consumption" spend across all stakeholders and understand the current impact of this spend.
- Using inputs from international programs and the co-design process, build plausible investment scenarios that could support an increased effort in a national change program – Plus One Serve - across priority settings.
- Build funding models for four scenarios, low, medium, high and optimal that map financials across an initial 6 year Plus One Serve program plus a further ten years of estimates (total 16 years of estimates). The model's details will inform a cost/benefit and economic impact analysis of the investment scenarios.
- The model will describe the investment across, years, funding providers (growers, government, commercial, research), settings (home, retail, education).

3.3 Part A. Behavioural intervention framework

3.3.1 Method

Module 3 Part 1 presents a new vegetable consumption behaviour change intervention framework that will inform the breadth and coordination of interventions required to increase vegetable consumption by one serve nationally by 2030 from the new base line outlined in Module 2 and in line with the rate of adoption model in Module 4.

The new **'Plus One' Behavioural Intervention Framework** has been developed through an evolving co- design process using:

- Academic based frameworks developed over the last 13 years by Prof. Susan Michie's of University College of London Behaviour Change Wheel first developed in 2011 following a literature and practice review and then analysis of major health programs in the UK
- The Shannon Company's and Monash BehaviourWorks intervention framework derived through practical application and review of Australia's successful long term change programs including – smoking cessation (QUIT), retirement saving/ superannuation (Industry Super Funds), women's health (This Girl Can), Water conservation during the Millennium drought (our water our future) and commercial success for increasing per capita consumption of Salmon with Tassal in 2018
- Dr Mark Boulet et al model 2021 on multi-level factors influence food behaviours and waste.
- Co design workshops with food and nutrition experts from academic, retail, manufacturing and behaviour change disciplines focussing on interventions across the five settings Home, ELEC, Primary school, Secondary and Tertiary and, Retail.
- Inputs from Module 1 Rapid Literature Review led by CSIRO.
- Research into vegetable consumer behaviour.
  - Fifty-five Five – Consumer U&A
  - Kantar – Vegetable Demand Space Framework
- Understanding of new baseline model developed in Module 2 led by Corporate Value Associates (CVA)

- Understanding of impact assessment model developed in Module 4 by Ag Econ, noting the rapid uptake required from 2027 to 2030.

The new **'Plus One' Behavioural Intervention Framework** forms a practical way of:

- Classifying and evaluating of interventions based on impact, scalability and ease of implementation, and
- Identifying where further research is required to refine intervention and gain necessary evidence to inform the necessary policy interventions to underpin sustained change.

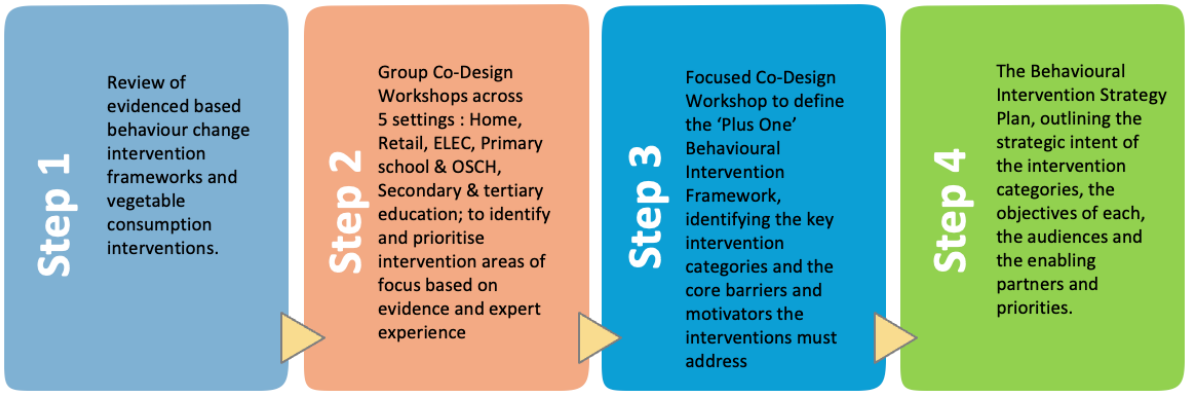


Figure 20 Summary of Part A methodology

3.3.2 Results and discussion

The report is structured to reflect the four steps of the evolving co-design process:

i. Review of academic and evidence-based behaviour change intervention frameworks and the core framework used for the co-design workshops.
ii. Summarises the outputs of the co-design workshops, the interventions and priority intervention areas identified through the process.
iii. Presents the new 'Plus One' Behavioural Intervention Framework, identifying the key intervention categories and the core barriers and motivators the interventions must address.
iv. Presents the Behavioural Intervention Plan, outlining the strategic intent of the intervention categories, the objectives for each, the audiences and the enabling partners and priorities.

Part i: Review of evidenced based behaviour change intervention frameworks.

In 2012 The Shannon Company in partnership with Monash University's Behaviourworks developed a behaviour change intervention toolkit as practical framework for behaviour change programs.

It is based on the work of Professor Susan Michie of the University College of London in the development of the Behaviour Change Wheel with the Com-B model at its heart. The 2011 work was based on the review of 19 global behaviour change frameworks. It links the identified sources of behaviour to appropriate intervention functions to guide the selection of behaviour change techniques and the design of effective interventions (see Appendix 3A).

The Shannon Company took this foundational academic work and applied it to Australian programs aimed at driving sustained societal change in the following areas:

- Valuing Water with conservation – sustained drop in per capita consumption from 247 litres per day to 165 litres in 6 years and it remains 15 years later.
- Road safety – 1034 deaths per annum in 1969 to 234 in 2023
- Salmon consumption – in 2018 a 4 % increase in per capita consumption in 1 year from 1.57kg to 1.63kg to 2kg per person in 2024
- Food waste – love a list program – 20% reduction in household food waste.

- Workplace safety – 30% reduction in workplace injury rate from 9 per million hours worked to 6 per million hours worked over 10 years.
- Superannuation and retirement saving – creation of a $1.6 T industry super fund sector that underpins the growth in total sector to $3t – and average savings per person to grow from $200k in 2024 to $500k in 2034.
- Women's physical health – 400,000 women more active every year for last 6 years.

The behaviour change intervention framework model for these programs was formalised by The Shannon Company and Monash's Behaviour Works in 2012.

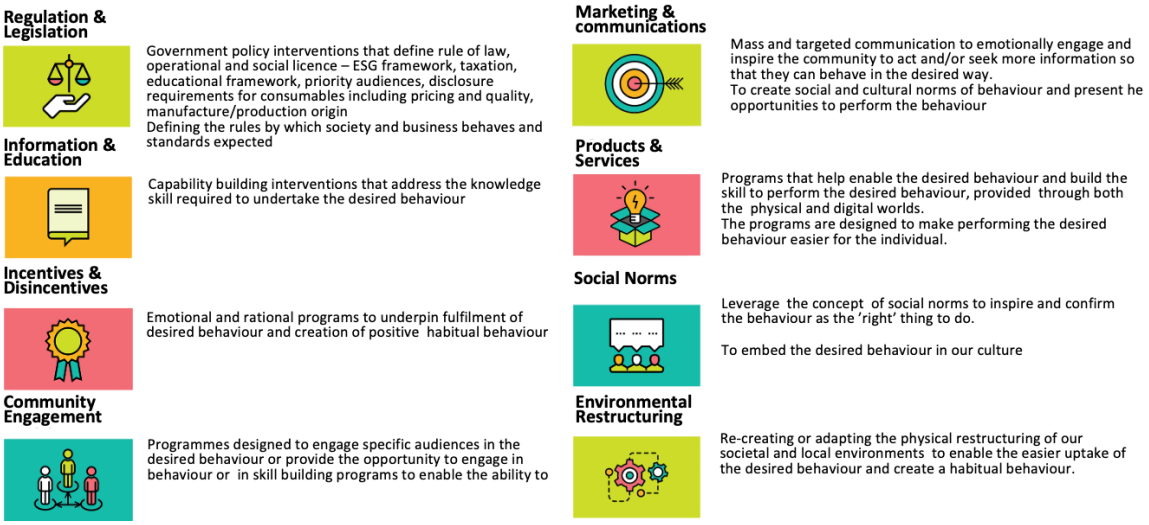


Figure 21 Intervention framework and strategic intent

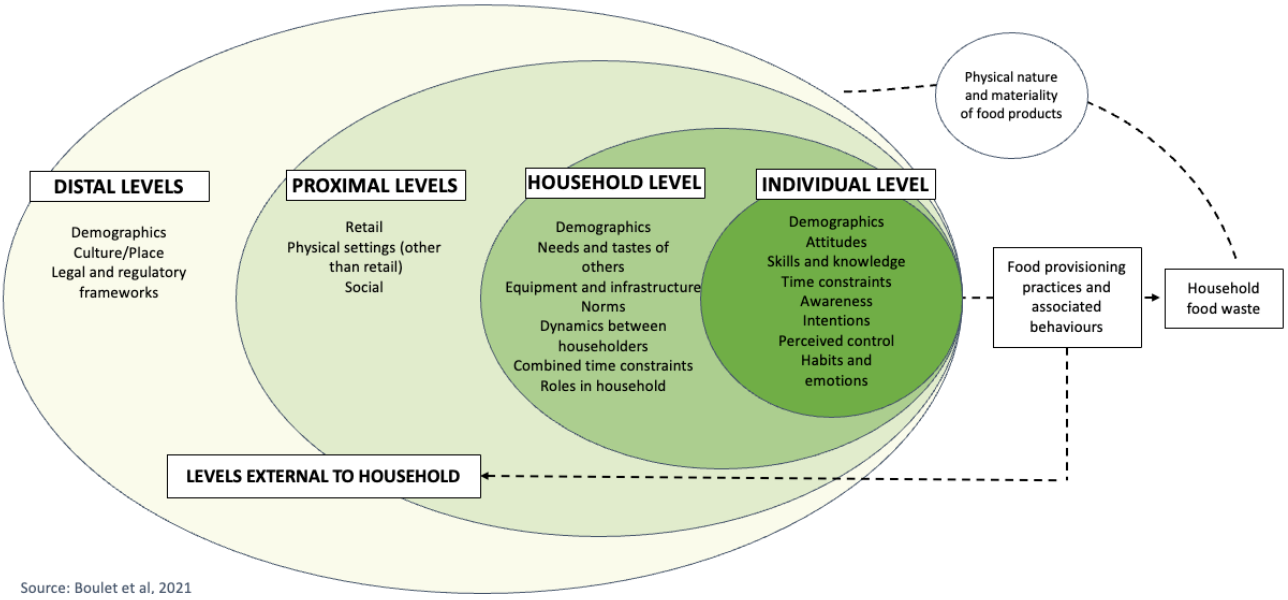


Figure 22 The multi-level factors that can influence food behaviours and waste

Part ii: Group Co-Design Workshops across 5 settings: Home, Retail, ELEC, Primary & OSCH, Secondary & tertiary education.

Co-design Workshop

The co-design workshop was conducted online with the participants previously acknowledged in this report.

The session was designed with an all-participants information sharing session to ensure common understanding:

1. Best Practice project update on rapid literature review + initial insights based on other programs of work (CSIRO)
2. Baseline data modelling – what's the real task? (CVA)
3. Economic Impact Assessment Update (AgEcon)
4. Behaviour Change Intervention and Food Behaviour Models (TSC/BWA and FVC)
5. Consumer Research Synopsis (Fifty-five Five /Kantar)
6. Retail Perspective (FVC)

The foundations session in the morning was followed by smaller co-design session with groups rotating through the 5 settings ELEC, Primary school and OSCH, secondary and tertiary, home and retail. The initial rotation was based on experts in that setting, following groups then were given the opportunity to build on the previous groups work and insight.

In these co-design sessions, a starting hypothesis for each setting based on previous FVC work was shared to stimulate discussion and as a basis for intervention ideation and discussion using the behaviour change intervention framework to guide the session and address key barriers/motivators. These barriers and motivators have been previously described in work by Kantar Domestic Growth Framework 2022, and KPMG "Shifting the Dial" – each report classifies aspects differently but in summary:

- Cost and Affordability
- Taste and Enjoyment
- Health and Environment
- Waste Avoidance
- Time and Convenience
- Skill – Knowledge, Inspiration and Ease
- Accessibility and Provisioning

The work identified a range of interventions, including some existing programs for each setting and areas for further research to be pursued through the MRT. In addition, there was some specific reference material shared through the discussion which is captured in Appendix 3B-3F.

The co-design program highlighted the need to focus on:

Table 9 Intervention areas of focused identified by the co-design program

Setting	Interventions	Description
ELEC	Provisioning	Through policy-based initiatives, funding alignment and corporate ESG alignment
	Education	Policy for curriculum, education training
	Incentivising	Adapt a commercial approach to the centres – e.g. higher AQUEA ratings for increased veg consumption
	Sensory play	Environmental restructuring to include veg gardens, veg focused play times
	Tie back to Home	Parent child recipes to prepare, sensory play toys
Primary	Provisioning	Through policy-based initiatives, ensure lower SES have availability funding alignment, NFP organization programs and corporate ESG alignment
	Education	Policy for curriculum, educator training
	Tech based game play	Aims to improve skills and educate on life integration e.g. supermarket
	Environmental restructuring	To include vegetable gardens, prep occasions and sharing enjoyment
	Tie back to Home	Parent child recipes to prepare
Secondary and Tertiary	Provisioning	Through policy-based initiatives, ensure lower SES have availability funding alignment, NFP organization programs and corporate ESG alignment
	Education	Policy for curriculum, educator training and food supply chain – meet the farmer
	Tech based game play	To improve skills and educate on life integration e.g. supermarket.
	Tech based skills/inspiration	App-based programs and AI based
	Emerging motivators	Environment and mental health were discussed and required more research
	Tie back to Home	Parent /teen recipes and provision of vegetables to prepare and enjoy together
Home	Tech based	Skills/inspiration – app-based programs and AI based (e.g. ChefGPT), hacks to improve taste and convenience and reduce waste – storage and leftovers
	Retail linkage	Affordability/value equation
	Emerging motivators	Environment and mental health were discussed and required more research
	Environmental restructuring	To include veg gardens, prep occasions and sharing enjoyment
	Veg Promotional messaging	To build inspiration and appetite appeal across occasion, skill and connected to further resources to improve skill
Retail	Pricing	Price per serve to build value equation mor easily and relevantly

	Tech based skills/inspiration	App-based programs and AI based
	Environmental restructuring	Improving display and associated messaging to help choose quality
	Accessibility	Targeted specifically to low SES, CALD rural/remote and indigenous
	Veg promotion	More prominent across all retail platforms (online/instore) that build value perceptions and build the skill to choose well, to optimise taste, enjoyment and convenience
	In store activations	Build skill, engagement and appetite appeal, bring farmer closer
	Products/services	Prepacked kits and instructions easy to pick up and go

More details on these settings can be found in Appendices 3B-3F.

Part iii. Focused Co-Design Workshop to define the 'Plus One' Behaviour Change Intervention Framework.

Review of past studies

The outputs from Step 2, including the behaviour change framework were analysed again. We also referenced and considered the findings of previous studies that were relevant to establishing an intervention framework for the Plus One Serve program. Specifically, we have referenced:

1. VG23005 Module 1: Best Practice Evidence Review of Reviews for Vegetable Consumption Interventions by CSIRO – summarising the interventions by setting and impact as per Module 1.
2. VG 22003 McKinna et al. Behavioural Change Plan to guide Levy Investment which identified the following intervention framework.
3. New baseline and impact modelling from VG 23005 Modules 2 and 4 which identifies the fundamentals of the challenge:
    a. Baseline of 1.8 serves per day currently and 90% of Plus One Serve in vegetable consumption coming from home and retail settings, and
    b. Plus one serve or more achieved by 2030 with accelerated uptake from 2027 onwards.
4. Review of barriers and motivators identified:
    a. KPMG Shifting the Dial on Vegetable Consumption Oct 2022
    b. Kantar Domestic Growth Framework June 2022

Tailored framework principles for Plus One Serve

In developing a more robust and tailored behavioural framework based on the evidence and broad-based expert review the following observations were made as points of principal:

- Agree common framework for interventions to not only overcome barriers, but also to take advantage of core motivators that can be applied by setting. It is not enough just to address the barriers to vegetable consumption; it is important we address the motivators to eat more vegetable consumption. These are not mutually exclusive in most instances but there are emerging motivators that deserve attention, for example the environment and mental health.
- Agree common language.
- Provide a means to classify interventions and later evaluate their ability to
    - Impact the Plus One Serve of vegetable mission across meal/snack occasions, the five settings and audience segments.
    - Scale to a national level and at speed to meet the required growth ambitions for the 2030 target.
    - Ease to implement the interventions across settings, audiences and nationally.

An expert advisory workshop was facilitated with Corporate Value Associates, AgEcon, AusVeg - The FVC and The Shannon Company team members to review all data and research inputs to co-design a National Behaviour Change

Intervention Framework that embraces the collective learning and evidence from all parties engaged in VG23005 and referenced data.

This evidence based, collaborative co-design process classified the barriers and motivators to be addressed as follows:

Identification of key barriers and motivators to vegetable consumption

Table 10 Key barriers and motivators to vegetable consumption

Key barriers and motivators	Descriptions
Accessibility and Perceived Value	Reflects the ease or otherwise to access the vegetables you want, (variety, quantity) physically and financially in a way that makes them easy and good value. People believe them expensive when priced on cost per kilo basis and because of high wastage due to quantity they need to buy (half a broccoli v whole) skill in preparing and storing. In the current cost of living crisis, cost for many is a dominant barrier to purchase and motivator for options.
Waste and Shelf Life	Reflects the issues around waste when not eaten and or not stored well. Research consistently highlights the issues of poor enjoyment and refusal to eat due to lack of skill, waste through not knowing what do with leftovers or not knowing how best to store different vegetables.
Quality and Variety	Reflects the lack of skill in judging quality of vegetables at purchase and in preparing. And the lack of variety and understanding in addressing taste and usage occasion opportunities
Taste and Enjoyment	Reflects the dominant need we have for food experience and the often-poor experience had at home with veg due to lack of knowledge, skill and time. This can particularly impact children and their consumption of vegetable.
Knowledge and Skill	The key issue behind low consumption as it pertains not only to the skill to prepare tasty and enjoyable veg easily, but also how to choose to veg, not waste veg and evaluate value more accurately. This is fundamentally important to all but critically to families where kids often become the lowest common denominator.
Convenience and Ease	In our time poor society, it is a fundamental requirement to make prep time short and easy, and easy to clean up with minimum fuss from those consuming – especially kids.
Wellbeing and Environment	While vegetables are intrinsically known to be good for you there is less understanding of different varietal benefits, including protein sources and the ability to provide good energy source. All powerful motivators that can also be tasty with right skill. There is emerging evidence on two other areas of motivation to eat more vegetables. Better environmental outcomes by eating less animal based foods. Better mental health through better diet and gut health.

As with the barriers and motivators the evidence reviews, research and co-design with sector experts summarised the following key interventions necessary for sustained behaviour change and achieving 'Plus One Serve" by 2030.

Identification of behavioural interventions critical to sustained consumption of more vegetables.

Table 11 Key barriers and motivators to sustained increase in vegetable consumption

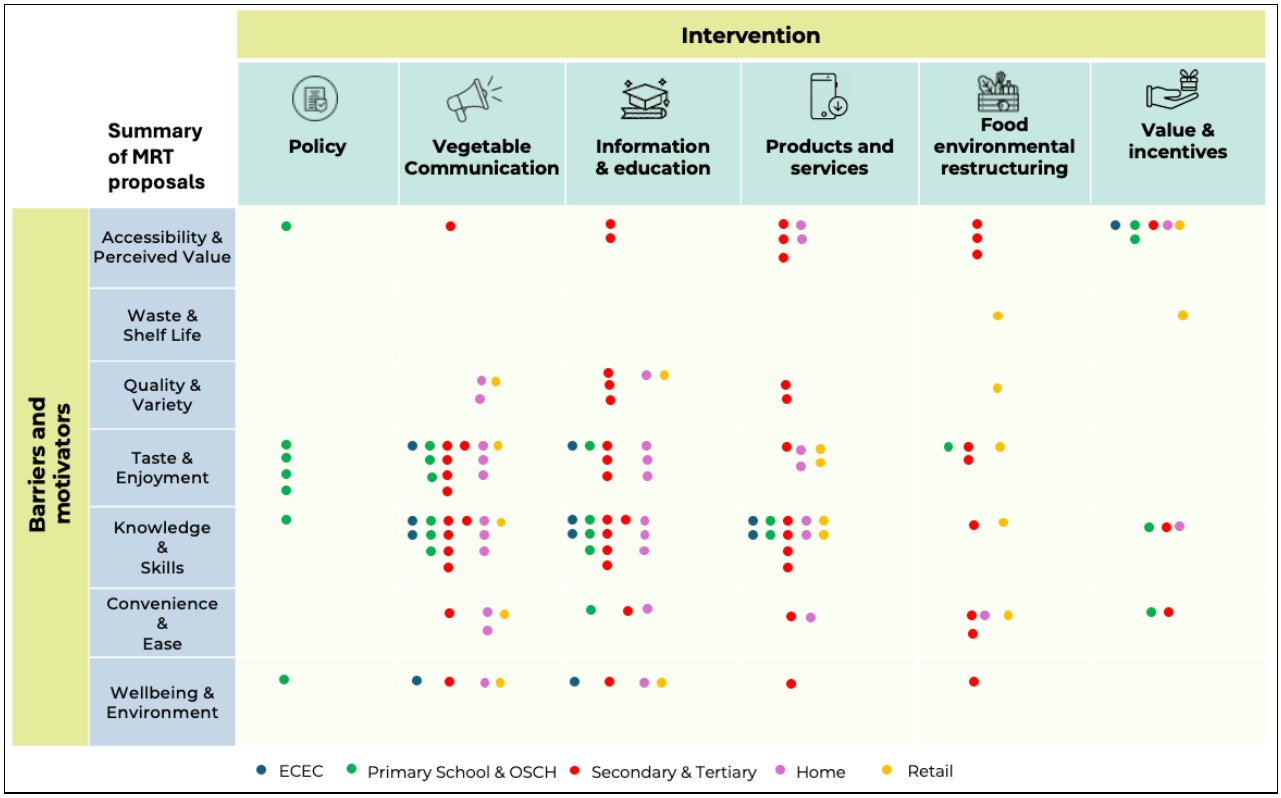
Key barriers and motivators	Descriptions
Policy	Government policy that enhances the provision and consumption of vegetables by providing the guardrails for setting participants to implement to establish the foundations for sustained behaviour change.
Vegetable communication	Communication at the mass and specific targeted audience level that unifies all activities, across all settings, all occasions, by all parties under one 'active brand' (e.g. SLIP SLOP SLAP). The communication is designed to improve capability and provide pathway to resources to products and services, increase motivation to consume more veg and

	overcome barriers to consumption. It should operate at mass and key segments, for low SES, indigenous, rural and remote, CALD audiences.
Information and education	Capability building interventions that address the knowledge and skill required to undertake the desired behaviour. Available at mass level but also specifically through each setting and to key audiences in ways that make it highly accessible.
Products and services	Capability building interventions that enhance the knowledge and skill required to overcome barriers, leverage motivators and undertake the desired behaviour of eating more veg across setting, target audience and occasion. The programs are designed to make performing the desired behaviour easier and more convenient for the individual and can be accessed in physical or digital world.
Food environmental restructuring	Refers to programs across all settings that improve the accessibility and engagement with vegetables. They can be in physical setting enhancing appeal and access and storage or in the online environment.
Value and incentives	Interventions designed to improve affordability, value perceptions and increase faster establishment of habitual behaviour of eating more vegetables across all meal and snack occasions.

In applying the framework to classifying the 6-year R&D program proposals associated with VG23005, it is noted there is a reasonable spread of coverage with many addressing more than one specific intervention area. Also of note are the areas where new and transformational R&D programs are required to understand behaviour change initiatives.

This is line with uplift in mixed strategies from VG23005 Module 1 Literature review and experience across other sectors and behaviour change programs.

Table 12 A de-identified summary of programs classified by the 'Plus One' Behavioural Intervention Framework



Part iv. The Behaviour Intervention Strategy Plan

This section sets out a series of summary models on how the interventions should be defined in terms of strategic intent, their priority enablers and then how each intervention addresses the core barriers and motivators; including what is required for success in terms of partners and enablers.

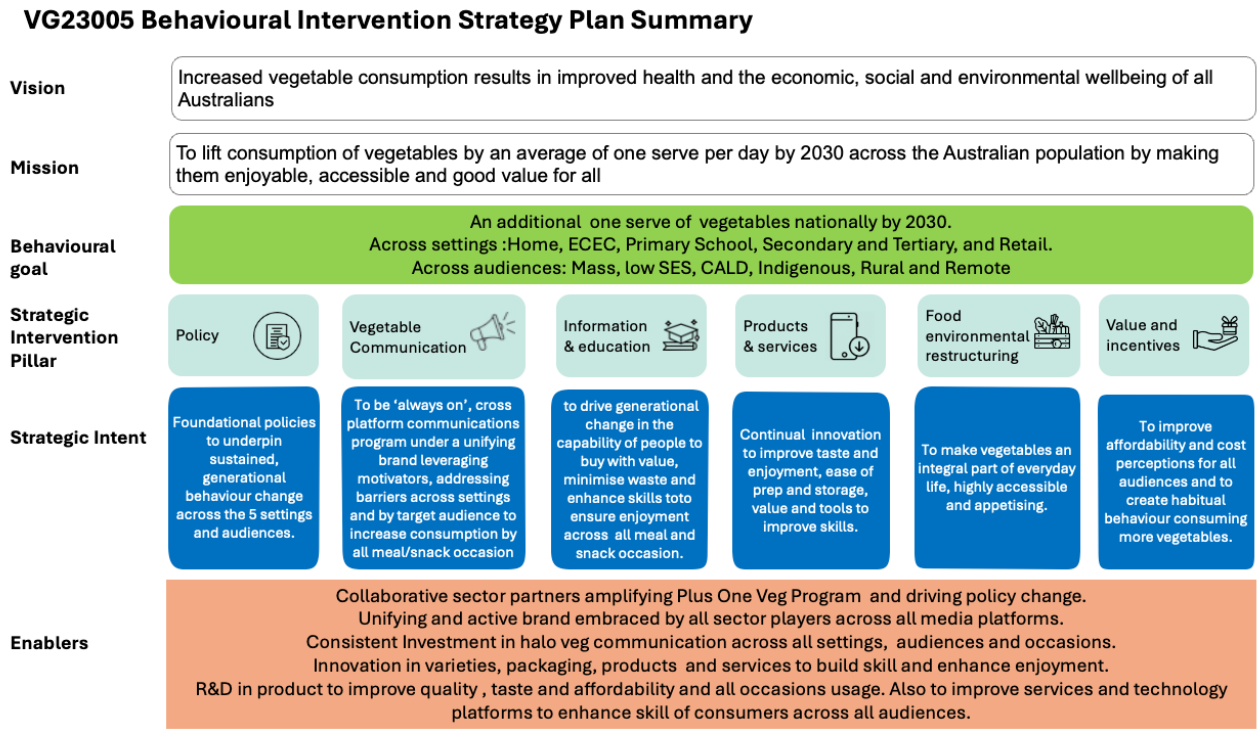


Figure 23 Intervention plan summary

The frameworks that follow expand on each of the key interventions and their role in addressing each of the key barriers and motivators identified by the new **'Plus One' Behavioural Intervention Framework.** A detailed breakdown of the framework can be found in Appendix 3J.

The framework is a robust tailored framework to guide interventions to increase vegetable consumption that through evaluation will positively contribute to the achievement of Plus One Serve by 2030.

Evidence consistently shows its success is how well the framework is used and the way that the interventions across all categories are curated, evaluated, evolved and consistently supported over time.

In Melbourne it took 7 years of consistent interventions and support to establish a new lower base line of per water capita consumption – 100 litres less per day that remains 17 years later even with over 1 million more people, demonstrating generational change and stronger valuing of water in the community.

It is the same for other programs we have been involved in road safety, smoking cessation, women's activity rates, workplace safety, salmon consumption.

3.3.3 Recommendations

That Plus One Serve incorporates the Behavioural Intervention Framework and Strategy Plan into their future Governance, strategic and operational plans.

3.4 Part B. Future investment scenarios

3.4.1 Method

Understand the elements of a successful national change program

National program design experts – The Shannon Company and Monash BehaviourWorks were engaged to describe the attributes of other national change management programs and to apply this logic to vegetable consumption and a national change management program as per Part 1 of Module 3. This informed the scenario investment design.

Analyse the current 'vegetable consumption' spend across all stakeholders and understand the current impact of this spend.

A desktop review of past and current vegetable programs and associated costs was complemented through consultations with FVC ecosystem of researchers, state/territory health promotion agencies, state government representatives, vegetable growers, grocery retailers and NGOs/NFP's who all provided input into the estimate of investment in initiatives that promote vegetable consumption.

All current known projects were summarised into the investment model as the current state.

Build investment scenarios

An understanding of the potential benefits from interventions was developed by the foundation research reviews undertaken by CSIRO as outlined in Module 1 of this report.

An understanding of where consumption occurred in Australia was updated via the baseline review as outlined in Module 2 of this report.

A workshop with key industry stakeholders considered the key variables influencing per capita consumption change informed the development of three scenarios (low, moderate, high).

International interventions and their associated costs were reviewed.

Estimates were made to take test-and-learn projects from research to state or national roll-out, estimates were made regarding the cost of impact in settings such as retail / consumer impact. These cost estimates informed the approach of costing national programs.

Further consideration was given to the importance of retail initiatives to underpin rapid national change in the home setting and the need to address the problem that vegetables are perceived as high cost. This led to the development of an optimal strategy that focused on value perception and education settings.

Based on detailed stakeholder engagement across a broad range of possible initiatives – the scenarios were converted into costs estimates across a 6 year (initial program to achieve 2030 Plus One Serve) plus a further ten years to give 16 years of forward estimates.

Test & Learn R&D to prove what works

In years one and two it is assumed that Hort Innovation and R&D partners will invest in research projects to test and prove efficacy of interventions aiming to improve vegetable consumption. This research will be co-funded, with 60% from delivery partners and 40% cash from Hort Innovation's Frontier Fund. If proven to increase vegetable consumption all efforts will be made to scale-up and rollout a program nationally.

Scale-up proven interventions

The FVC and other experts assume that by year three, proven interventions will be scaled-up and reach beyond the original research environment settings. For the various investment scenarios, we have identified the main sources for this scale-up and roll-out to be funded by a mixture of investment from:

- Commonwealth Government
- State & Territory Governments and health agencies
- Vegetable Growers

- Grocery Retailers
- Health NGO's and NFP's
- Other health and horticulture-related commercial businesses

Hockey Stick Investment & Ongoing R&D

Investment for scale-up is likened to a 'hockey stick' - increasing sharply as research interventions are proven and scaled for national impact. Scale-up and roll out activity assumes a high level of co-operation and co-ordinated effort from all stakeholders. Testing and trialling interventions across all priority settings will continue as proven programs are rolled out.

3.4.2 Estimating current vegetable promotion investment

It is estimated that $101.5m is currently invested each year by various organisations to promote vegetable consumption in Australia.

Table 13 Estimated proportion of investment each year by various organisations to promote vegetable consumption

Funding Organisation	Investment $
State & Territory Governments incl. health promotion and public health agencies	$27,000,000
Commonwealth Government	$2,000,000
Hort Innovation	$2,000,000
Food Industry advertising	$5,500,000
Corporate vegetable growers	$5,000,000
Grocery retailers	$50,000,000
Other NGOs and NFPs	$10,000,000
Estimated annual vegetable promotion	**$101,500,000**

The FVC ecosystem of researchers, state/territory health promotion agencies, state government representatives, vegetable growers, grocery retailers and NGOs/NFP's have collaboratively input to generate this estimate of investment in initiatives that promote vegetable consumption. A database of more than 100 mapped programs was circulated to over 20 investor organisations for review and input into program costs. Overall, the consensus amongst stakeholders was that determining 'vegetable specific' investment was challenging. It is impossible to quantify the resources invested by both the public and private sectors, which would likely amount to many tens of millions of dollars (The Fruit Vegetable Consortium, 2020).

Current investments by State & Territory Government

Spending from state/territory Governments is difficult to calculate, given the difficulty assigning a spend associated to vegetable consumption out of a total healthy eating or healthy living program expenditure. New South Wales, Queensland, Victoria, South Australia and Western Australia governments with their public health agencies spend an estimated average of $4.5m annually to promote vegetable consumption. Tasmania, Northern Territory and Australian Capital Territory spend an estimated $1m to $1.5m per year.

These estimates were generated from a program data base and further consultation with FVC ecosystem stakeholders familiar with the funded programs and jurisdictions. Such programs include LiveLighter, Crunch & Sip, Healthy Easting Advisory Service (HEAS), FreshSnap (WA), Pick of the Crop, (QLD) Active & Healthy (NSW), The Get Healthy Service (NSW), Healthy Eating Local Policies and Program, Fresh Tastes, Make Healthy Happen and Eat Well Tasmania.

Current investments by Commonwealth Government (direct investment)

In 2023-2024 the Australian Government budget allocated $378.8m for preventative health measures with only a small proportion being allocated specifically for vegetable awareness and promotion activities. The Commonwealth Government invests directly in its Eat for Health program and other ADG-related communication.

Current investments by Grocery retailers

Australian grocery retail is dominated by Woolworths and Coles, claiming 37% and 25% of market share respectively, followed by Aldi 12% and Metcash with 10% share. Other independent green grocers and smaller chains such as Foodworks, Foodland, Drakes, Harris Farms and The Friendly Grocer make up the remainder (Statista, 2023).

Retailers have considerable resources that are applied to omni-channel marketing efforts across mass media (TV, print, radio, OOH, digital), in-store display and promotion, e-commerce, email and mobile marketing, social channels, product catalogues and branded magazines, sponsorship and loyalty programs.

With the largest retailers spending an average of $100 million each and Aldi around $50 million on advertising each year, it is estimated 7-9% could be attributed to vegetable marketing. (Nielsen Ad Intel, 2024). This however does not include the value of other promotional efforts such as weekly catalogues and instore promotion. Adding the other smaller retailers spends the whole of retail vegetable marketing spend is estimated to be $50 million per year.

With 80% of Australian vegetables being sold through retail, it is these businesses that hold the key to generating demand. That said, all levels of government do invest in programs to encourage people to consume a healthy diet rich in vegetables while large corporate growers embark on their own marketing initiatives and campaigns.

Current investments by Hort Innovation

Investment in vegetable R&D via Levy and Frontiers Funding is estimated to total $9-10 million over the next five years (Hort Innovation 2021, Vegetable Strategic Investment Plan 2022-2026).

Current investments by Food Industry

Approximately 1% of all food advertising in Australia is attributed to the promotion of vegetables. It is assumed that Australia shares a similar profile with the UK and Canada with vegetable spend representing only 1% and 0.8% of total advertising spend respectively (BMC Public Health, 2022).

Current investments by Corporate Vegetable Growers

Australia's largest corporate growers, such as Perfection Fresh, Fresh Select, One Harvest, Mitolo, and Flavorite engage in vegetable marketing and promotion direct to consumers while also selling produce into retail.

Current investments by NGO, NFPs

Other non-government programs are delivered by health-nutrition organisations such as Cancer Council, Heart Foundation, Nutrition Australia, The Kitchen Garden Program and food relief charities.

3.4.3 Estimates to rollout national setting-based programs

Funding sources in forward estimates

Funding models to support the scale up of a national change program in vegetable consumption were developed based on the priority settings established by the FVC. This funding mix has been applied to all four scenarios in the model of the forward estimated budget.

Table 14 Funding sources in forward estimates across five priority settings

Funding Organisation	Estimated investment %				
	ELEC	Primary Schools & OSCH	Secondary & Tertiary Education	Home	Retail
State & Territory Governments incl. health promotion and public health agencies	40%	50%	50%	20%	10%
Commonwealth Government	10%	10%	10%	10%	5%
Hort Innovation/ AUSVEG	5%	5%	5%	5%	5%
Other commercial investors	15%	0%	0%	0%	0%
Corporate vegetable growers	5%	10%	10%	10%	20%
Grocery retailers	10%	10%	10%	25%	50%
Corporate Early Learning Businesses	15%	15%	15%	30%	10%

Funding quantum by setting in forward estimates (Low and Optimal scenarios)

Table 15 Funding quantum by setting over next six years (Low vs. Optimal scenarios)

Scenario	Setting	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Total incremental investment by setting – **Low** ($million)	ELEC	1.75	1.75	4.5	4.5	4.5	4.5	21.5
	Primary	2.5	1.25	6	6	6	6	27.8
	Second/tertiary	1.5	1.25	4.5	4.5	4.5	4.5	20.8
	Home	5	2.5	15	15	7.5	7.5	52.5
	Retail	5	2.5	15	15	7.5	7.5	52.5
	Plus One Serve project coordination	1.70	1.70	1.70	1.70	1.70	1.70	10.2
	National Behaviour Change Campaign	6.67	6.67	6.67	6.67	6.67	6.67	40.0
	Total (Low)	**24.1**	**17.6**	**53.4**	**53.4**	**38.4**	**38.4**	**225.2**
Total incremental investment by setting – **Optimal** ($million)	ELEC	31.3	35.2	17.1	16.7	16.8	11.2	128.2
	Primary	37.5	22.7	34.2	33.3	16.8	22.4	166.9
	Second/tertiary	18.8	11.4	17.1	16.7	8.4	5.6	77.9
	Home	50.0	45.5	68.3	66.7	67.1	44.8	342.4
	Retail	50.0	45.5	68.3	66.7	67.1	44.8	342.4
	Plus One Serve project coordination	1.7	1.7	1.7	1.7	1.7	1.7	10.2
	National Behaviour Change Campaign	16.7	16.7	16.7	16.7	16.7	16.7	100.0
	Total (Optimal)	**205.9**	**178.6**	**223.4**	**218.4**	**194.6**	**147.1**	**1,168.0**

Early Learning Education Centres (ELEC)

Modelled from existing state and territory program funding and other industry investments it is estimated that a national vegetable program would require an investment of at least **$21.5 million** over a six-year period.

This assumes a national rollout across all states and territories will reach 50-100% of early learning centres by 2030 (~8,500 centres). Currently each state or territory funds various services to support early learning centres provide healthy food and drinks to children – with states and territory investing between $1 - $1.7m to support early learning centres. Hort Innovation-funded VEGKIT ($4m over five years 2017 -2022) developed best practice guidelines to increase vegetable consumption across several education settings, but fell short of scale-up and roll-out.

Primary Schools & OSCH

Modelled from existing state and territory program funding and other school-based activities, such as Crunch&Sip, Try for 5, Pick of the Crop, VegEducation and The Kitchen Garden Program, it is estimated that a national program would require an investment of at least **$27.8 million** over six-years.

This assumes a high level of cooperation and co-ordination to rollout across all states and territories to reach 50-100% of all primary schools by 2030. At present no national co-ordinated schools program focused on vegetable consumption exists per our research. Each state or territory funds various services to support primary schools to encourage students to consume a healthy diet rich in vegetables, for example HEAS (Victoria) and FreshSnap (WA).

Secondary Schools & Tertiary Education

It is estimated that a national vegetable program for secondary schools would require an investment of at least **$20.8 million** over a six-year period. This is calculated from knowledge of existing state and territory program funding and other school-based activities such as VegEducation, Try for 5, food relief provision and education/skill development and high-profile Kitchen Garden Program.

It is assumed a national rollout across all states and territories would reach 50-100% of all secondary schools and tertiary institutions by 2030. State and territory governments fund various services to support secondary schools to encourage students to consume a healthy diet rich in vegetables via Health & PE curriculum, Food Tech subjects healthy canteen initiatives.

It is assumed tertiary institutions will adopt healthy food charters and engage with Plus One Serve program for ongoing test and learn initiatives that address education, skills development and food security.

Home

It is estimated that a rollout a home-based vegetable program would require **$52.5 million** over six-years potentially and reach 50-100% of all households by 2030. Modelled from existing state and territory and Commonwealth program funding and other campaigns delivered into the home setting (such as retail) a national program would focus on developing knowledge and skills to prepare vegetables. Currently each state or territory funds various services to support individuals and families to consume a healthy diet rich in vegetables. Current funded program examples include LiveLighter, Crunch & Sip, Active & Healthy, The Get Healthy Service, SA Healthy Eating Local Policies and Program, Fresh Tastes, Make Healthy Happen and Eat Well Tasmania.

Retail

It is estimated that an investment of at least **$52.5 million** over six-years is required. It is assumed that a national rollout of an umbrella Plus One Serve brand and value perception interventions across all states and territories and major retailers would reach 75-100 % of all shoppers by 2030 (estimated 9,100 stores). Any retail program would require a high level of co-operation and goodwill from retailers and the vegetable industry, but with it significant opportunity to influence what Australians buy and consume.

Coles and Woolworths together have 65% share of market, Aldi 10%, along with independent green grocers and smaller chains like IGA. Retailers spend in excess of $40 million each year promoting fresh vegetables with advertising, branded channels, instore promotion as well healthy eating programs and initiatives like the Woolworths weekly Fresh Market Update, Discovery Tours, Fruit & Vegetable Superhero Builders, Eat A Rainbow, and Reward Points.

3.4.4 Developing Investment Scenarios

In estimating the investment required to increase vegetable consumption four investment scenarios have been developed. These scenarios capture co-investment from Hort Innovation and other commercial and government stakeholders with a vested interest in increasing vegetable consumption. It is hypothesised here that a collaborative co-investment model has potential to increase vegetable consumption by one serve per person per day by 2030.

Investment scenarios up to and including (2025-30)

The following are the four investment scenarios for the coming six-year period to FY30 - developed as a key input for the assessment of the impact of varying levels and mixes of co-investment on national vegetable consumption.

Table 16 Incremental investment levels

Scenario	Total incremental investment over six years
Low	Total additional investment of $225 million
Medium	Total additional investment of $711.5 million
High	Total additional investment of $1.135 billion
Optimal	Total additional investment of $1.168 billion

The investment scenarios have been developed as additional spend through the Plus One Serve programme, that is additional to the current $101.5 million per annum spend on vegetable consumption. Total spend will be the sum of the current spend plus the new spend as per Table 16.

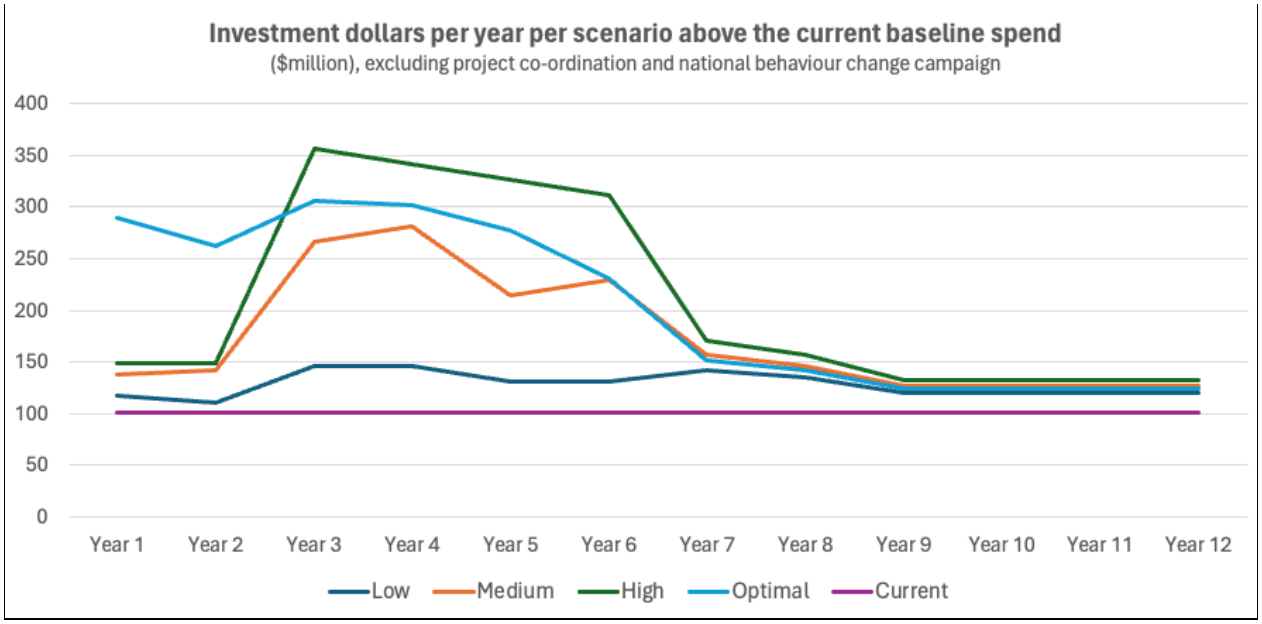


Figure 24 Deployment of investment for each investment scenario over time

Optimal investment scenario – Build value perception and generational vegetable demand

The core hypothesis is that an adjustment to the medium investment level scenario creates this fourth investment scenario which will require an additional $1.168 billion over a six-year period (equivalent to an additional $1.328 billion over 12 years), from a variety of funding sources: Hort Innovation R&D, R&D partners, grocery retailers, government and the commercial sector.

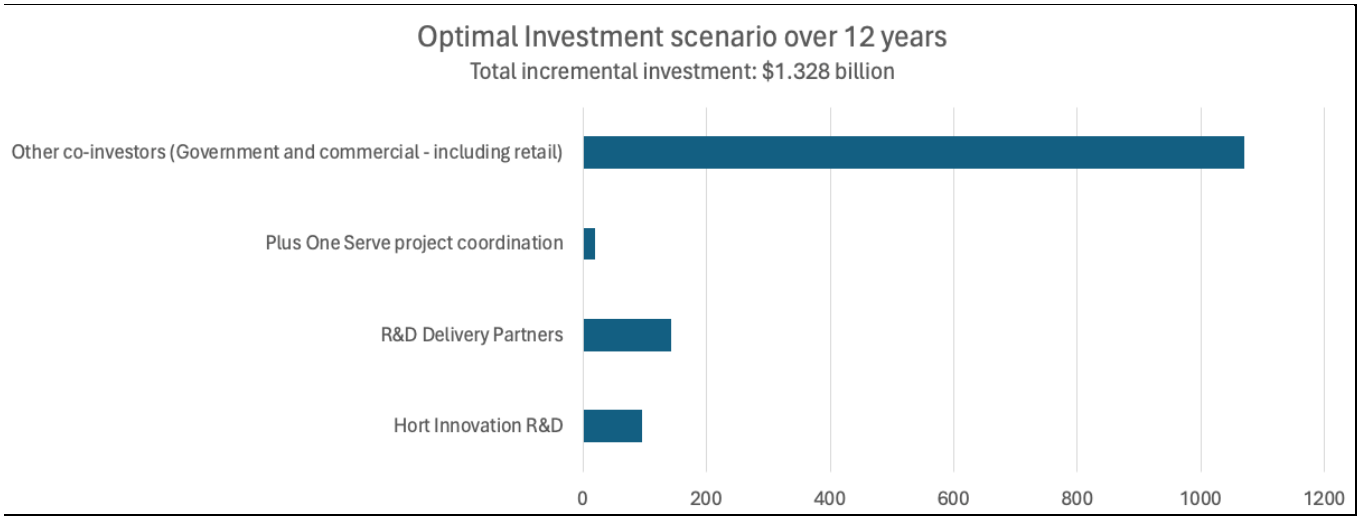


Figure 25 Optimal Investment scenario 2025-2037

3.4.5 Discussion

Drive improved value perception, drive usage at home, build generation vegetable demand

The Optimal Scenario places funding emphasis on investment in retail value perception strategies and the rollout of a national vegetable program within the home setting.

More than 80% of vegetables grown in Australia are sold through approximately 9,100 retail outlets. (Hort Innovation, 2023). Market share concentration for the supermarkets and grocery stores industry in Australia is high, with the top four companies generating more than 70% of industry revenue (Grigg, 2024). Australia's grocery buyers together make an estimated 1.9 billion separate trips to the supermarket every year. For every $1 spent on vegetables $0.65 is spent in a Woolworths or Coles store, then followed with $0.10 for Aldi. Australian households spend on average $160 per week on groceries, equating to almost $693 a month or $8,320 a year.

The average weekly spend for larger households of five or more people is roughly $204, with most of this spent on staple or everyday food items. Most Australians visit a supermarket at least once a week, with 65% reportedly purchasing both fruit and vegetables (Wallis, Godfrey,2024). Thus, the retail environment represents a significant opportunity to influence what Australians purchase to consume across all settings.

Test, learn, rollout across Retail

The optimal scenario would test, pilot and report on retail interventions and initiatives in the first twelve months. If successful, rollout will commence shortly thereafter and aim to dramatically scale-up for national reach after three years. This scenario is enabled by a high level of retail co-operation and investment of $125 million of value per year for three years. It is assumed retailers will make the required changes across their networks to support transformational strategies and programs that will deliver significant economic returns to both retailers and vegetable growers. Secondly, this scenario calls for similar levels to investment in a home-based vegetable program to build knowledge, skill and agency amongst all members of a household. These efforts should focus on value perception, preparation/waste avoidance, convenience and address all eating occasions for maximum influence across the other settings (for example, in school and workplace lunchboxes). As such, it is modelled that 75% of investment in years one to six will be directed to retail and home setting initiatives.

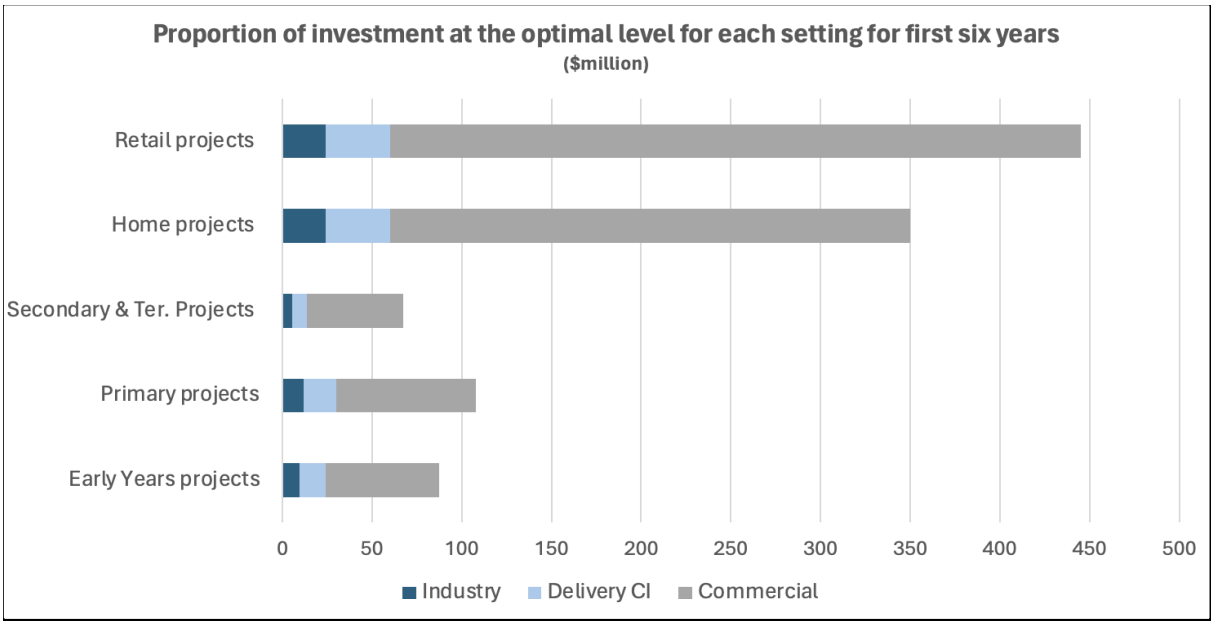


Figure 26 Total proportion of investment at the 'Optimal level' for each setting

Building knowledge & skill at home

With vegetable demand increasing in retail, a home-based program to support families to develop vegetable knowledge, occasion-based preparation and cooking skills will be launched. Evidence suggests that that interventions promoting vegetable consumption should be carried out at an early age and involve parents, who are the main caregivers and influencers of their children's behaviour within the home. Parents can encourage their children in several ways: eating healthy themselves, making vegetables constantly available at home, structuring mealtime routines, and insisting on offering vegetables at mealtimes or as a snack. Generation change will begin at home and be supported across the key education environments – those being primary and OSCH, secondary and tertiary education settings.

Investment in education continues

Investment in the three education settings would continue under the *Optimal Scenario* and be framed by the national behaviour change program and an umbrella brand that connects activities in and outside the home and across all five priority settings.

3.4.6 Conclusion

- An estimated 274 percent increase in current investment is needed to raise average Australian vegetable consumption from 1.8 to 2.8 serves per person per day by 2030. (This estimate compares the current $101.5 million annual investment to the $1.668 billion total investment proposed in the Optimal investment scenario over the next six years).
- This study proposes that the most efficient way to achieve Plus One Serve is by prioritising investment in retail and the home setting where reach is close 90-95% of all Australians.
- This will require an estimated investment of $1.168 billion over a six-year period from 2025 to 2030.
- Sustained changes to Australian's relationship with vegetables is proposed to start where food is purchased by addressing consumer misconceptions that vegetables are too expensive, might be wasted or are too difficult to prepare.
- The key to success starts with generational change from the home through to children in education settings where healthy eating can be reinforced to build life-long vegetable eating habits.

3.4.7 Next steps

The impact of these investment scenarios will be modelled by AgEcon and The CIE as per Module 4.

Scenario development and modelling can be an iterative process. The impact model created for the investment scenarios described here can re-applied in the future to estimate the impact of new investment scenarios and importantly be used to measure the success of a live program.

4 Economic impact assessment

4.1 Introduction

Module 4 “Impact Modelling” quantified the expected economic and social impact of increasing vegetable consumption through delivery of the *Plus One Serve of Vegetables by 2030* (Plus One Serve) Program. Understanding the potential impact of the Plus One Serve Program is required to inform delivery strategy, prioritise investment and communicate Program the value of the Program. This report provides a detailed description of the impact assessment methodology and results for all modelled scenarios, including the level of consumption change and the subsequent modelled impact areas reflecting reduced health care costs and increased vegetable and supply chain industry value.

The report is structured as follows:

Part 1 provides a description of the consumption change model, and outcomes of the four modelled scenarios (low, medium, high, optimal). The modelling method, inputs, and scenario results are presented in detail.

Part 2 describes the disease burden and healthcare model. This provides the basis for estimating the benefit of reduced healthcare expenditure resulting from increased vegetable consumption. The modelling method, inputs, and results are discussed for each scenario. The modelling method, inputs, and scenario results are presented in detail.

Part 3 describes the supply chain economic model and data. This provides the basis for estimating increased vegetable industry value and broader economic benefits (e.g. jobs created). The modelling method, inputs, and scenario results are presented in detail.

Part 4 consolidates the results from Part 2 and Part 3 into a total program benefit and compares this to total Program investment costs.

Part 5 and Part 6 provides conclusions and recommendations for future impact assessment, including reflections on other potential drivers of impact which could not be reliability quantified due to data gaps.

4.2 Part 1. Consumption change model

4.2.1 Method

A desktop model was developed using Microsoft Excel software to calculate changes to national per capita vegetable consumption. The model covered a 20 year period (2024-25 to 2043-44). The model was built to reflect consumption change for a given age group in line with the five priority settings.

The five core components of the model were:

1. Population growth

Population projections by year of age for the period 2023-24 to 2033-34 (ABS 2023a) were applied to the five priority settings based on appropriate age brackets. The model allows age cohorts to be influence by more than one setting concurrently (e.g. home setting and early learning setting) as well as sequentially (e.g. moving from the early learning setting to the primary school setting).

2. Target reach

The speed of rollout and the target audience reach reflect the extent to which the interventions are successful at engaging with the target cohorts. It was assumed that rollout would include a research phase, pilot stage, and full-scale rollout by 2030, with the resulting reach growing rapidly towards the end of RD&E (reflecting a “hockey stick curve”).

3. Consumption changes

Evidence collated through Module 1 informed potential levels of consumption change that could be achieved through exposure to settings-based interventions.

The model assumed that consumption change is not specific to an intervention setting, that is, vegetable consumption events can be influenced by multiple interventions. Therefore, the model reflects the potential for two interventions to have a cumulative or layering effect on consumption change. This cumulative effect is one of the potential benefits of a program approach and is further discussed below.

4. Timeline for behaviour change

Depending on the type or intensity of the intervention the timeline for behaviour change could reasonably be expected to vary from being immediate (such as for meal provision in Early Years) to taking some period of time as the target audience takes an experimental approach to testing and accepting increased vegetables in their diet (such as at home or in school canteens). However, as no data was identified to quantify this change over time, a time period ranging from 0 years (immediate effect), 1 year, and 2 years was assumed until full behaviour change is realised following initial intervention exposure.

5. Program effects on consumption

The Plus One Serve Program delivery will be coordinated through a strategic delivery approach that targets priority settings and complementary intervention approaches. The Program also intends to establish a common measurement framework that can be consistently applied across settings. As a result, the overall program delivery approach is expected to support synergies that otherwise would not be realised from a series of stand-alone interventions. As no data was identified to quantify this effect, a cumulative program factor was applied with a value of between 1.00 (no synergies generated by delivering the interventions in a program) and 1.50 (program synergies generating a 50% higher behavioural (consumption) change compared to what would have been achieved by delivering the interventions independently).

Concurrent interventions are cumulative across settings

The concurrent program effect reflects a potential benefit of a program that delivers concurrent overlapping interventions. The assumption is that a benefit can be generated by delivering concurrent interventions in a program framework to achieve a higher consumption increase than if the interventions were delivered independently. For example, the students in a school setting receive the benefit of exposure to interventions delivered across both the school setting and the home setting that have complimentary and coordinated messaging

Sequential interventions are cumulative across settings

This reflects a potential benefit of a program that delivers sequential interventions that accumulate over a person's lifetime. The assumption is that a benefit can be generated by delivering the coordinated sequential interventions in a program framework to achieve a higher consumption increase than if the interventions were delivered independently. For example, students progressing from an Early Years setting to a Primary School setting that has complimentary and coordinated messaging would retain any initial behavioural change that has already occurred.

4.2.2 Inputs

Reflecting the above method, modelling inputs were developed for three intervention scenarios through Module 3 (Workshops to Shortlist Interventions). The three scenarios reflected broad outcomes for each of the modelling inputs: Low, Mid, High. The modelling inputs drew on empirical data where possible, with assumptions developed by the panel of experts to fill any data gaps.

The Low, Mid and High consumption change scenarios were run through the model with sensitivity testing conducted to identify the key drivers of consumption change. These preliminary results were reviewed by the project team to identify a fourth optimised scenario which prioritises investment that will most efficiently achieve the outcome of Plus One Serve by 2030 (see *Sensitivity testing*).

The modelling inputs for each of the four intervention scenarios can be found in Appendix 4A.

A fifth baseline scenario was also developed reflecting vegetable consumption trends without any intervention. This baseline scenario was developed from the HiLink modelling framework, considering the interaction of projected supply and demand trends. The baseline starting point (2022-23) was aligned to the Module 2 Consumption Baseline.

4.2.3 Results

Applying the scenarios to the consumption change model generated a national average vegetable consumption increase of between 0.11–1.37 serves per person per day by 2030, and 0.13–1.65 serves per person per day by 2044 (Figure 27). A "Plus One Serve" scenario is included for comparison.

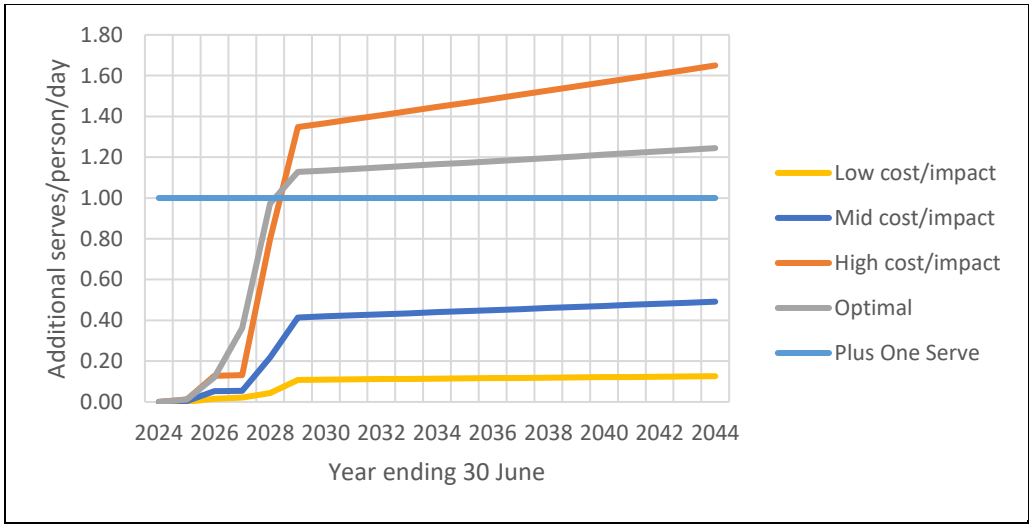


Figure 27 Additional serves per person per day from the baseline

Figure 28 shows the resulting total vegetable consumption across the scenarios.

- Baseline projection. A projected decrease in vegetable consumption from the Module 2 Baseline of 1.79 serves/person/day to 1.78 serves by 2030 (-0.6%) and 1.77 by 2044 (-1.4%).
- Low cost/impact scenario. Increasing to 1.89 serves by 2030 (+0.11 serves or +6.1% from the 2023 baseline), and 1.90 serves by 2044 (+0.13 or +7.0%).
- Mid cost/impact scenario. Increasing to 2.20 serves by 2030 (+0.42 serves or +23% from the 2023 baseline), and 2.26 serves by 2044 (+0.49 serves or +27%).
- High cost/impact scenario. Increasing to 3.15 serves by 2030 (+1.37 serves or +76% from the 2023 baseline), and 3.42 serves by 2044 (1.65 serves or +92%).
- Optimal scenario. Increasing to 2.92 serves by 2030 (+1.14 serves or +63% from the 2023 baseline), and 3.01 serves by 2044 (+1.24 serves or +69%).
- Plus One Serve scenario. Increasing to 2.78 serves by 2030 (+55% from the 2023 baseline), and 2.77 serves by 2044 (+54%).

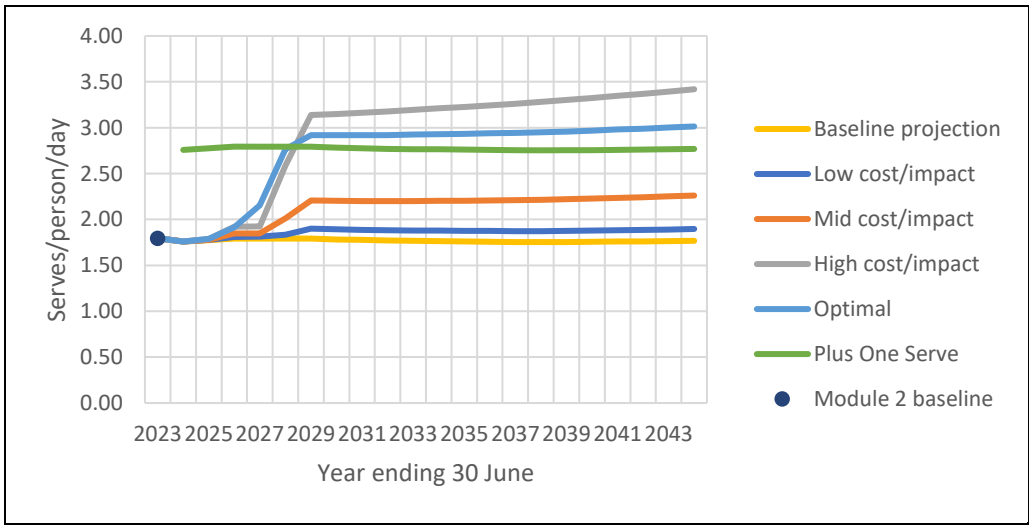


Figure 28 National average vegetable consumption

4.2.4 Sensitivity testing

Contribution of key model components to the total consumption change

The contribution of key model components to the national average consumption change is shown in Figure 29 and Figure 30. In the low and moderate scenarios, the home and retail settings contribute the largest amount to the national change in vegetable consumption owing to both their high per person consumption change effect and their national reach. In the high scenario, the concurrent program effect had the highest contribution to the national consumption change as a result an assumed capacity of program delivery to drive a layered, cumulative consumption effect. The sequential program effect, reflecting the cumulative benefit of being exposed to interventions at different life stages, has a low contribution to the overall impact due to the relatively low number of people (ages 0-24) that move through multiple settings within the 20-year modelling timeframe. In the high scenario, the school setting's contribution to national consumption changes increased relative to the others due to having a significantly larger upside consumption effect relative to the other settings identified in the Rapid Review (Module 1).

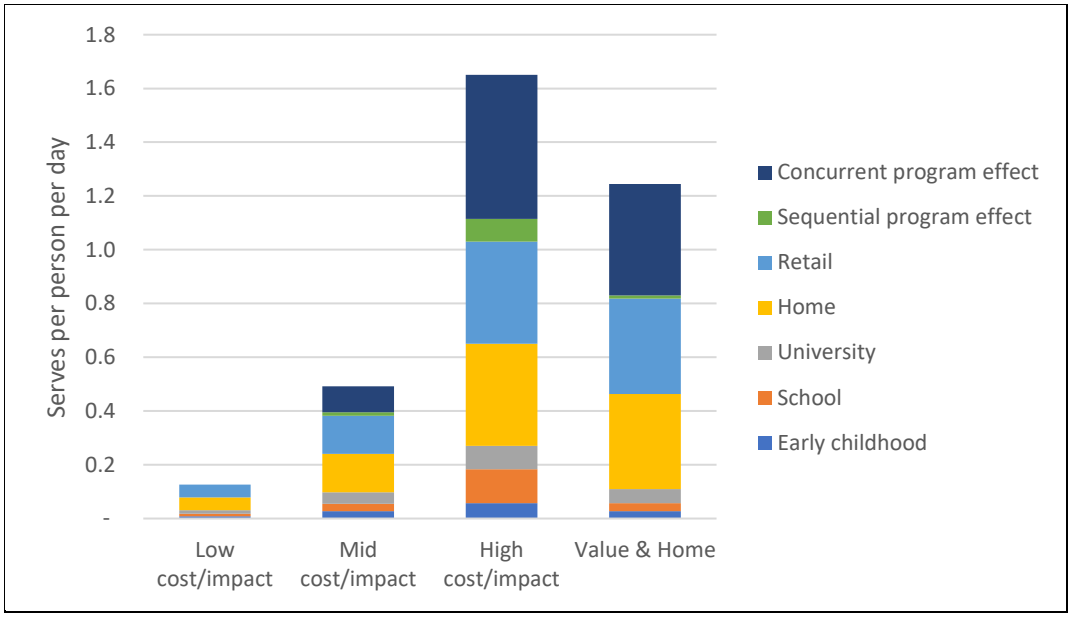


Figure 29 Serve per person contribution to national consumption change

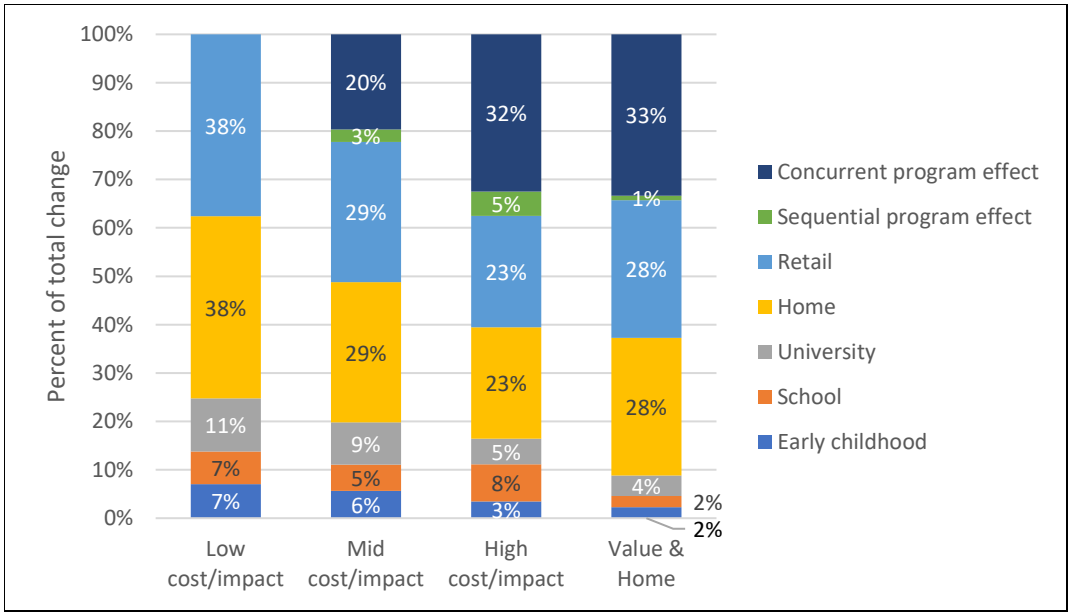


Figure 30 Percent contribution to national consumption change

Sensitivity testing of national consumption change to modelling parameters

The results were most sensitive to combined changes in the consumption across all settings reflecting the high, medium and low results of the Rapid Review (Module 1) (Figure 31). This variable also showed a large upside reflecting the findings of the Rapid Review. Within this, the home and retail consumption change level had the largest upside effects on the results, reflecting the consumption change ranges of the Rapid Review (Module 1), which was amplified by the large population reach of these settings. The speed and level of rollout achieved by the interventions had the third largest upside effect and the largest downside effect of a single variable (excluding the combined consumption change scenario). The concurrent cumulative effect had the fourth largest effect on the results. The primary school consumption had a large upside influence on the results reflecting the findings of the Rapid Review (Module 1). Beyond these five, the remaining modelling variables had a marginal effect on the results.

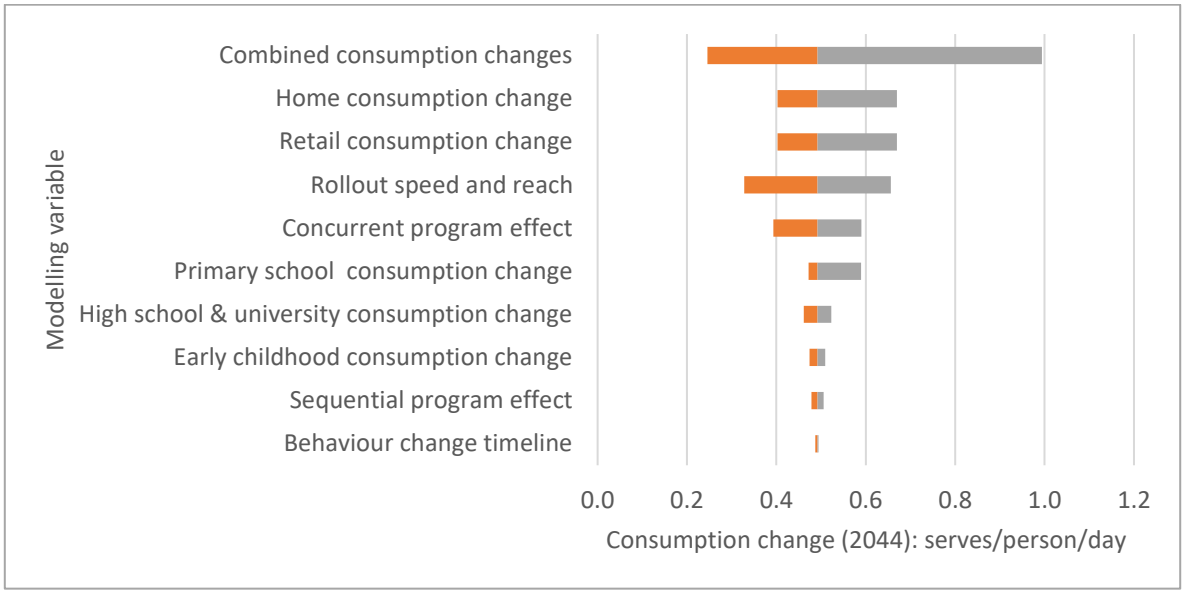


Figure 31 Sensitivity of the results to changes in modelling variables (from mid cost/impact scenario)

The sensitivity testing showed that in order to achieve Plus One Serve of vegetables within the modelling timeframe (to 2043-44), the following was required:

1. Maximum reach and consumption change in home and retail.
2. Maximum consumption change in home and retail, and maximum concurrent effect.
3. Maximum reach and consumption change in school plus home *OR* retail, and maximum concurrent program effect.
4. Maximum reach across all settings; maximum consumption change in early childhood, school, and secondary/tertiary, and maximum concurrent program effect.

Table 17 Modelling inputs achieving Plus One Serve by 2044

Modelling input name	**1. Maximise home and retail settings**	**2. Maximise home and retail program**	**3. Maximise school and home/retail program**	**4. Maximise rollout with youth program**
	+1.04 serve by 2044	+1.02 serve by 2044	+1.02 serve by 2044	+1.02 serve by 2044
Rollout/reach by year (by year of investment)	Max reach (home & retail)	NA	Max reach (all settings)	Max rollout (all settings)
Consumption change (serves/person/day)	Max consumption change (home & retail)	Max consumption change (home & retail)	Max consumption change (school & home *OR* retail)	Max consumption change (early learning, school, & secondary/tertiary)
Concurrent program effect	NA	Max concurrent program effect	Max concurrent program effect	Max concurrent program effect

The sensitivity analysis results identified that the outcomes of single modelling inputs are not sufficient to achieve Plus One Serve by 2030. However, the modelling inputs most sensitive to supporting change were identified to support the most efficient pathway to achieving Plus One Serve by 2030. These inputs were combined to support an optimised fourth scenario as follows:

- Optimal: Combining modelling inputs 1 & 2 from Table 17 to maximise reach and consumption change the in home and retail settings and maximise the concurrent program effect.

4.3 Part 2. Disease burden and healthcare cost model

4.3.1 Method

The method for estimating the relationship between vegetable consumption and healthcare costs followed six steps:

1. Health conditions influenced by vegetable consumption.
2. Projected national risk of identified health conditions, considering a growing and aging population.
3. National healthcare costs resulting from the identified health conditions.
4. Change in disease risk resulting from vegetable consumption.
5. Baseline (without investment) vegetable consumption projections.
6. Scenario (with investment) vegetable consumption projections.

4.3.2 Inputs

Health conditions influenced by vegetable consumption

Key diseases impacted by vegetable consumption were identified from Aune et al (2017), Stanaway et al (2022). Cardiovascular disease (CVD), broken down into Coronary Heart Disease (CHD) (Aune et al 2017, Stanaway et al 2022), stroke (Aune et al 2017, Stanaway et al 2022), and other CVD (Aune et al 2017); All cancer (Aune et al 2017); and Type 2 diabetes (Stanaway et al 2022).

Projected national risk of identified health conditions

The national risk of the health conditions identified in step 1 were estimated by combining the prevalence of each disease (AIHW 2023a,b,c,d) and the population projection (ABS 2023a) to generate a baseline time series of disease risk in Australia. The national risk of each disease was converted to an index from the Consumption Baseline year of 2022-23 (Module 2).

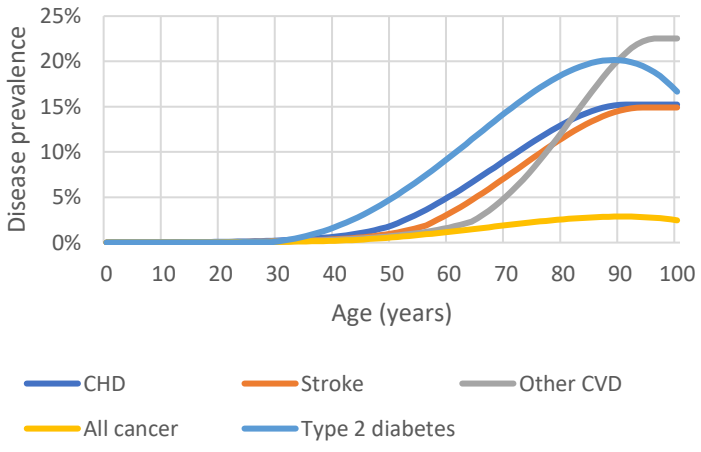


Figure 32 Incidence of diseases in the Australian population

National healthcare costs

The most recent healthcare spending data (2020-21) for the four identified diseases (AIHW 2023) was projected forward to match up with the baseline consumption year from Module 2 (2022-23). The annual healthcare spending for each disease for 2016-17 to 2020-21 was converted to 2023-24 equivalent values using the GDP deflator (ABS 2023b). From these real (inflation adjusted) figures the average growth rate was used to project spending forward to

2022-23. The final baseline health expenditure costs for each health condition are shown in Figure 33. The indexed national risk for each disease was applied to the baseline disease healthcare costs generating a projected healthcare expense (with flat vegetable consumption).

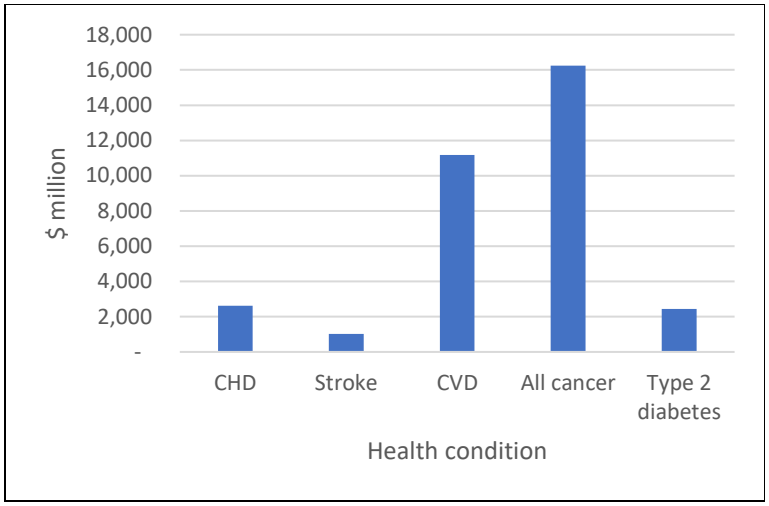


Figure 33 Disease expenditure in Australia 2022-23

Change in disease risk resulting from vegetable consumption

Drawing on data presented by Aune et al (2017) and Stanaway et al (2022), the relationship between vegetable consumption and disease risk was estimated (Figure 34). This relationship was used to adjust the projected national healthcare costs for varying levels of vegetable consumption including the baseline (without investment) vegetable consumption projections, the low-mid-high cost scenarios, the Optimal scenario, and the Plus One Serve scenario.

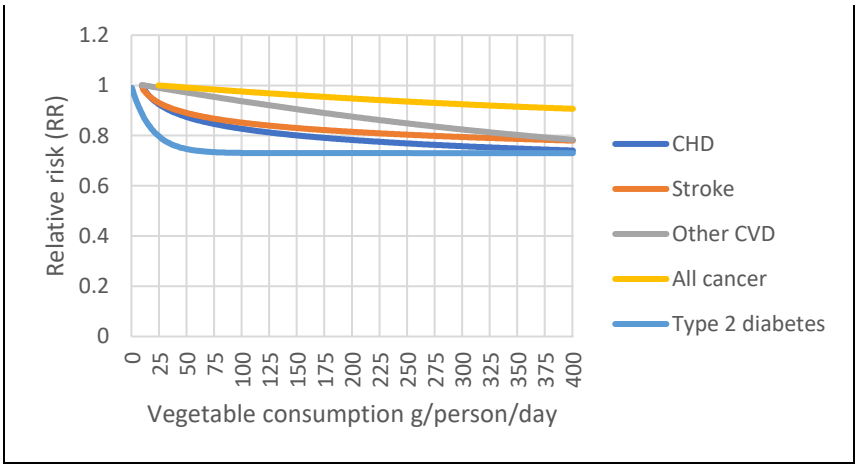


Figure 34 Disease relative risk with changing levels of vegetable consumption

The relationships for vegetable consumption and disease relative risk are shown in Table 18.

Table 18 Disease relative risk curves

Disease	Relative risk (RR) curve Where c = vegetable consumption per person per day in grams	Source RR curves estimated from data provided in:
CHD	RR = 1.1921E+00$c^{-7.9435E-02}$	Aune et al (2017), Stanaway et al (2022)
Stroke	RR = 1.1398E+00$c^{-6.3299E-02}$	Aune et al (2017), Stanaway et al (2022)
Other CVD	RR = 5.1726E-07c^2-7.6967E-04c+1.0086E+00	Aune et al (2017)
All cancer	RR = 2.4861E-07c^2—3.5386E-04c+1.0085E+00	Aune et al (2017)
Type 2 diabetes	RR = 0.26 x 2.5E-01^{4E-02c}+7.3E-01	Stanaway et al (2022)

Comparisons with previous research

In 2016 Deloitte estimated the implications of increased vegetable consumption on health-care costs and grower returns (through the vegetable R&D levy project VG15031). The Deloitte analysis estimated a 10% increase in vegetable consumption would result in $100 million per year in health-care cost savings, and $23 million per year in additional profit for vegetable growers.

The analysis used for Module 4 uses a slightly different approach by considering intervention rollout and reach, with an equivalent 10% increase in vegetable consumption in 2024 resulting in a $198 million health-care cost reduction; double the Deloitte estimate. The likely reasons identified for the difference are:

- **Different referenced studies**. Deloitte drew on five studies to quantify the relationship between vegetable consumption and disease risk: Aune et al (2011); Leenders et al (2014); Wang et al (2014); Wang et al (2015); and Zhang et al (2015). In contrast, this analysis drew on two more recent studies. The first study was a dose-response meta-analyses (Aune et al 2017) which considered the findings of many of the sources by Deloitte, noting that some of the previous results had been inconclusive (Zhang et al 2015), or flawed in design (Wang et al 2014). The second study was a burden of proof meta-analysis (Stanaway et al 2022) which sought to quantify the quality of evidence of previous studies, which identified slightly but not significantly stronger effects of vegetable consumption on reduced disease incidence compared to Aune et al (2017). These different reference studies resulted in:
  - **The addition of Type 2 diabetes** as a health condition associated with vegetable consumption in this analysis.
  - **The breakdown of CVD into CHD, stroke, and other CVD** with individual relationships between vegetable consumption and relative disease risk.
  - **Different disease risk curves** comparing vegetable consumption (grams per person per day) to disease relative risk. The relative risk curve for CVD in the Deloitte study showed a stronger relationship between vegetable consumption and health. For example, moving from the baseline consumption 135g/person/day to 219g/person/day (2030 Optimal scenario) would result in a 6% decrease in CVD in the Deloitte model. In contrast, in this model the relative risk declines by 4% (CHD), 3% (stroke), and 5% (other CVD). As a result the Deloitte study generates larger CVD healthcare benefits compared to this analysis. A comparison of cancer risk outcomes could not be made as the Deloitte study did not provide the formula for the cancer relative risk curve.
- **A different year of reference** for baseline healthcare costs, resulting in baseline healthcare costs being 29% higher in this analysis for CVD and All cancers, or 39% higher when Type 2 diabetes is also included.
- **A different modelling approach** to estimating the effect of changes in consumption of healthcare costs. The Deloitte analysis first estimated the proportion of healthcare costs that are attributed to vegetable consumption. For each disease, the disability adjusted life years (DALY) resulting from low vegetable consumption was compared to the total DALY giving a proportion of healthcare costs attributable to low vegetable consumption. This attributable healthcare cost was then reduced using the relationship between vegetable consumption and disease risk (disease relative risk curve). Identifying the proportion of healthcare costs attributable to low vegetable consumption suggests that if vegetable consumption were increased sufficiently, these healthcare costs could be fully avoided. However, as the disease relative risk curves consider changes in total disease risk with changes in vegetable consumptions, they will never reach a point of zero risk (i.e. changes in vegetable consumption can only partially reduce the disease relative risk given that other factors also contribute to disease risk). This means that there is no way for the healthcare costs attributable to low vegetable consumption to be completely removed even with high levels of vegetable consumption. In effect, this means that the Deloitte analysis has added an extra step to isolate the relationship between vegetable consumption and health conditions when this is already implicit in the disease risk curves. In contrast, this analysis applied the reduced disease risk curve directly to the total healthcare cost for each disease.

4.3.3 Results

Applying the four scenarios to the healthcare expenditure model resulted in reduced annual health expenditure of between $0.15–1.64 billion in 2030, and $0.22–2.56 billion in 2044 (Figure 35). Plus One Serve is included in Figure 35 for comparison. Despite remaining stable at Plus One Serve, there is an upward trend in health care benefits due to the increasing population projection.

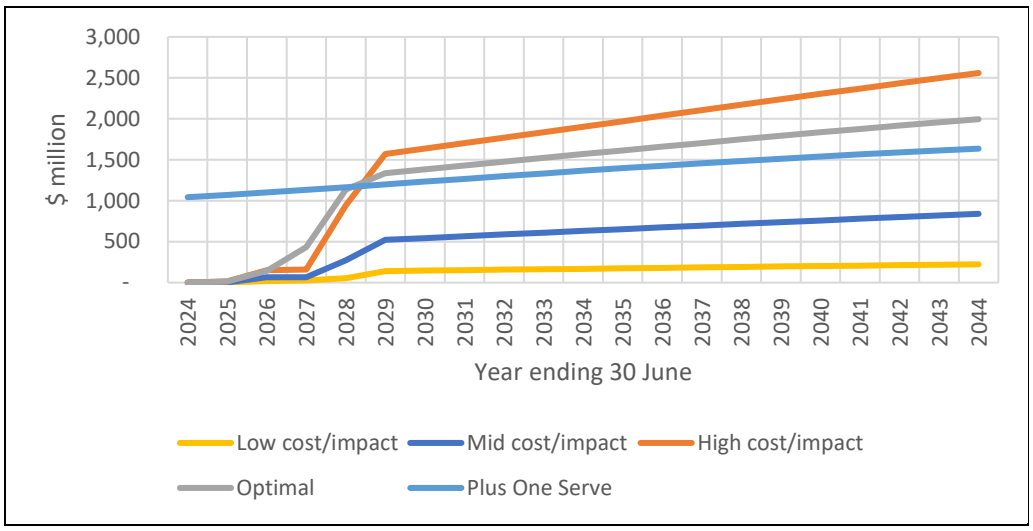


Figure 35 Health care expenditure benefits

Low cost/impact scenario

The *low cost/impact* scenario generated health care savings of $0.15 billion in 2030 and $0.22 billion in 2044, with a total saving of $3.0 billion over the 20 year modelling period.

The benefits were driven by reductions in disease incidence and healthcare expenditure for Other CVD (56%), Total cancer (31%), CHD (10%), Stroke (3%) and Type 2 diabetes (<1%).

Mid cost/impact scenario

The *mid cost/impact* scenario generated health care savings of $0.54 billion in 2030 and $0.84 billion in 2044, with a total saving of $11.3 billion over the 20 year modelling period.

The benefits were driven by reductions in disease incidence and healthcare expenditure for Other CVD (56%), Total cancer (31%), CHD (10%), Stroke (3%) and Type 2 diabetes (<1%).

High cost/impact scenario

The *high cost/impact* scenario generated health care savings of $1.64 billion in 2030 and $2.56 billion in 2044, with a total saving of $34.38 billion over the 20 year modelling period.

The benefits were driven by reductions in disease incidence and healthcare expenditure for Other CVD (57%), Total cancer (32%), CHD (8%), Stroke (3%) and Type 2 diabetes (<1%).

Optimal scenario

The *Optimal* scenario 1 generated health care savings of $1.38 billion in 2030 and $2.00 billion in 2044, with a total saving of $28.55 billion over the 20 year modelling period.

The benefits were driven by reductions in disease incidence and healthcare expenditure for Other CVD (57%), Total cancer (32%), CHD (8%), Stroke (3%) and Type 2 diabetes (<1%).

4.4 Part 3. Supply chain economic model

4.4.1 Method

A detailed horticultural industry value chain model, the HiLink, was used to estimate the economic benefits resulting from increased consumption of vegetables. HiLink is a partial equilibrium economic model of the horticulture supply chain which was initially developed by the CIE for Hort Innovation in 2008 for the development of horticultural industry strategy. HiLink is a national model that distinguishes between 48 commodities covering fresh, processed and amenity horticulture across all production regions. The HiLink model considers supply and demand factors along the supply chain from any external "shocks" (such as the application of interventions to increase consumption). This approach contrasts with previous work (Deloitte 2016) that assumed any increase in vegetable demand could be met with increased supply, resulting in no price changes. In contrast, the HiLink model recognises production constraints that generating price increase as a result of increased demand.

The method for estimating the economic impact of increased vegetable consumption included the following steps:

1. Update the HiLink model database drawing on the Hort Stats Handbook (Hort Innovation 2024) and horticulture trade data (IHS Global 2024).
2. Project and refine the baseline to align with the Consumption Baseline (Module 2).
3. Adjust the consumption change scenarios developed in Part 1 to reflect changes in vegetable sales. the consumption change estimated in Part 1 were adjusted to account for supply chain wastage, with the total change in sales equal to consumption plus supply chain wastage. Drawing on data from the National Food Waste Strategy Feasibility Study (FIAL 2021), Module 2 estimated total post-farmgate food waste of 41% in the retail consumption channel, and 83% in the food service consumption channel.
4. Apply the consumption/sales scenarios to the HiLink model. Changes in consumption/sales were applied as a proportion of existing sales.

From the above process the following economic impact metrics were estimated.

Value of output: The sales value of the additional vegetable purchases. Value of output was calculated for four supply chain sectors: Farm and processing, wholesale, transport and distribution, and retail and food service.

Value added: Value added reflects the difference between the cost of intermediate goods and the final value of output, with the additional value generated through the use of available land, labour and capital (which includes profit). Value added reflects the contribution to gross regional product (GRP), gross state product (GSP) and gross national product (GDP). Value added was also calculated at the four supply-chain sectors: Farm and processing, wholesale, transport and distribution, and retail and food service

Employment: Changes in full time equivalent (FTE) employment within vegetable production and processing.

All figures presented are direct impacts relating to vegetable supply chain activity. Indirect effects from horticulture supply chain activities including production and consumption induced effects are not specifically part of the HiLink model but have been calculated previously with a combined (type 2) multiplier of approximately 1.29 for value added impacts and 1.23 for employment impacts (The CIE 2023).

4.4.2 Results

The total annual economic impact is presented for all scenarios, with a supply-chain and regional breakdown of the 2030 impact for the preferred Optimal scenario.

Time series of total economic impact for all scenarios

The total annual value-added impact for the four scenarios is presented in Figure 36. Across the four scenarios, the total impact ranged from $0.18–4.19 billion in 2030, and $0.28–6.85 billion in 2044.

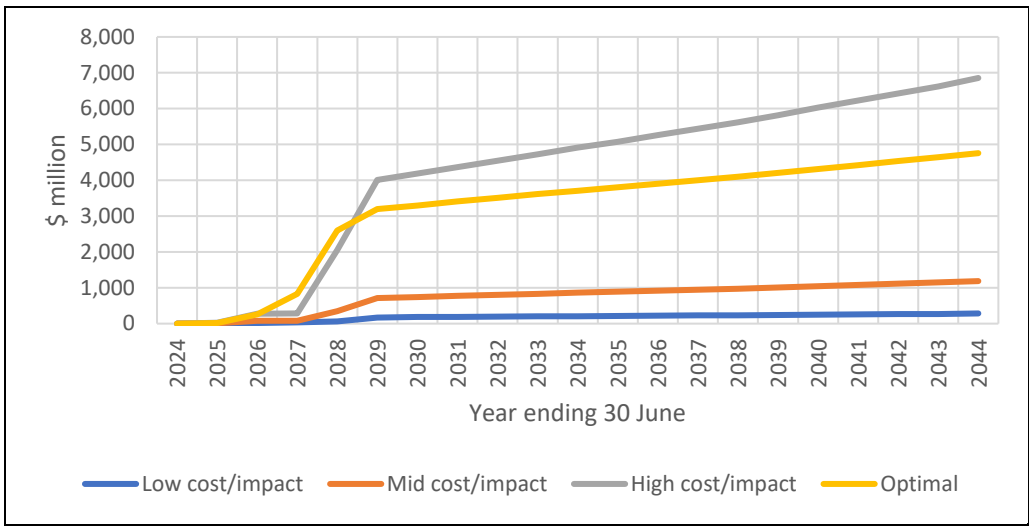


Figure 36 Time series of total supply chain economic impact (value added)

Distribution of economic benefits along the supply chain

The distribution of the 2030 benefits for the Optimal scenario are shown in Figure 37. The total increase in vegetable sales value (at the point of consumption through retail and food service channels) in 2030 was $7.91 billion, while the total value added was $3.30 billion. When considering sales value, the farm/processing share of total sales value of $3.54 billion (45% of total value) is approximately equal to the retail and food services sales value of $3.34 billion (42% of total value); however, when considering value added, the farm/processing sector generated $2.73 billion (83% of total supply chain value added) compared to $0.49 billion at the retail/food service sector (15%).

The distribution of these benefits reflects the nature of the supply response at the farm level for vegetables in the value chain. With an increase in demand, the farming sector is relatively unresponsive to increased prices as a result of constraints imposed by land and labour supply. In the short term, this is the same mechanism that results in highly variable prices when demand falls (due to COVID-19 for example), or there is a sharp reduction in supply in a region — which cannot be readily filled by other regions. Given an increase in demand over the long term, growers will increase areas planted, also requiring an expansion of their workforce. The required increase in supply to the domestic market will also be supplied by high imports and lower exports as marketers divert product back locally in response to higher prices

Value added includes payments to all factors of production (land, hired and owner-operated labour, capital and profit) is not a measure of profit for an individual business. Farm business profit as defined by ABARES (2019) is more relevant to assess the payoff to farm businesses who contribute levies. [1]For 2018-19, farm business profit across all vegetable-growing farms was 11.2 per cent of the gross value of production. [2] Applying this to the increase in the gross value of production from the Optimal scenario benefits for 2030, this amounts to an improvement of $370 million across all farms. If the number of farms in 2030 remained at similar levels to those in 2017-18[3], this would represent an average increase of around $160,000 per farm.

[1] Farm business profit is defined as Farm cash income plus build-up in trading stocks, less depreciation and the imputed value of the owner–manager, partner(s) and family labour.

[2] ABARES (2019) Table 3. Farm business profit for 2018-19 of $124,000 divided by Vegetable receipts of $1,108,000 (average per farm).

[3] ABARES (2019) reported 2,323 vegetable growing businesses in 2017-18.

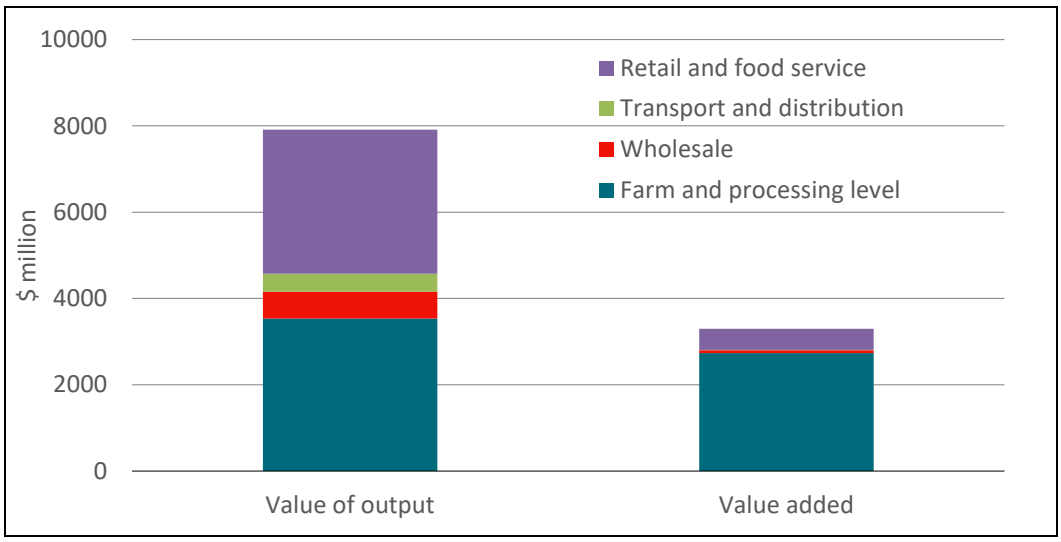


Figure 37 Breakdown of benefits along the supply chain (Optimal 2030)

Distribution of economic and employment benefits across the regions

The Optimal scenario benefits in 2030 were broken down by region including for economic contribution (value added) and employment benefits (Figure 38). The regional breakdown is presented for the combined farm and processing sectors, as the HiLink model does not allow for estimates of these figures for downstream sectors (wholesale, retail and food-service sectors). The regional benefits reflect the location of vegetable production, which has been previously covered in more detail in *Economic contribution of Australian horticulture (MT21010)* (The CIE 2023).

The modelling showed total direct employment benefits of 12,841 full time equivalent (FTE) for the farm and processing sectors.

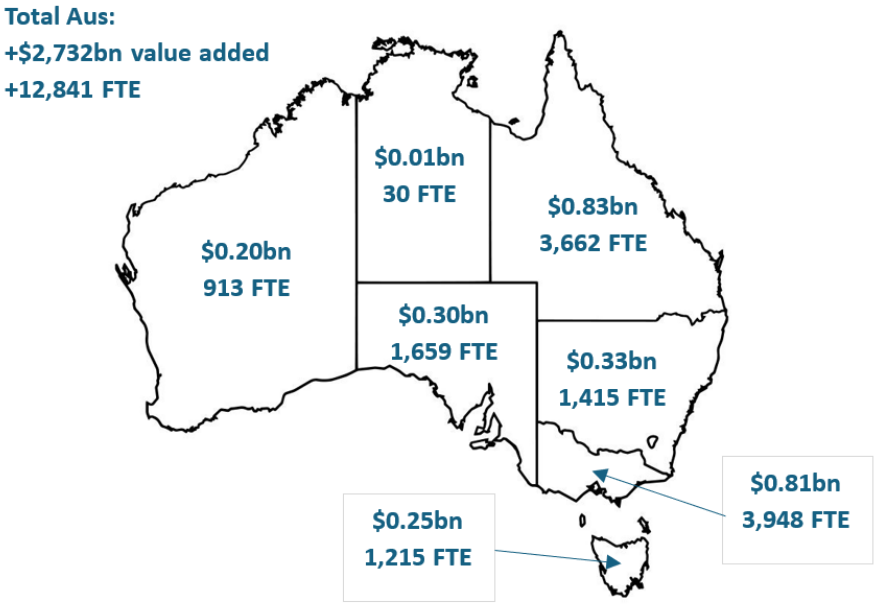


Figure 38 Regional breakdown of farm and processing value added and employment benefits for the Optimal scenario in 2030

Distribution of economic benefits across the vegetable commodities

The Optimal scenario 2030 value-added benefits for the farm and processing sector were broken down by individual vegetable commodities (Figure 39). As the changes in consumption and sales were applied as a

proportion of existing volumes, the distribution of benefits reflects exiting (without investment) sales and economic activity.

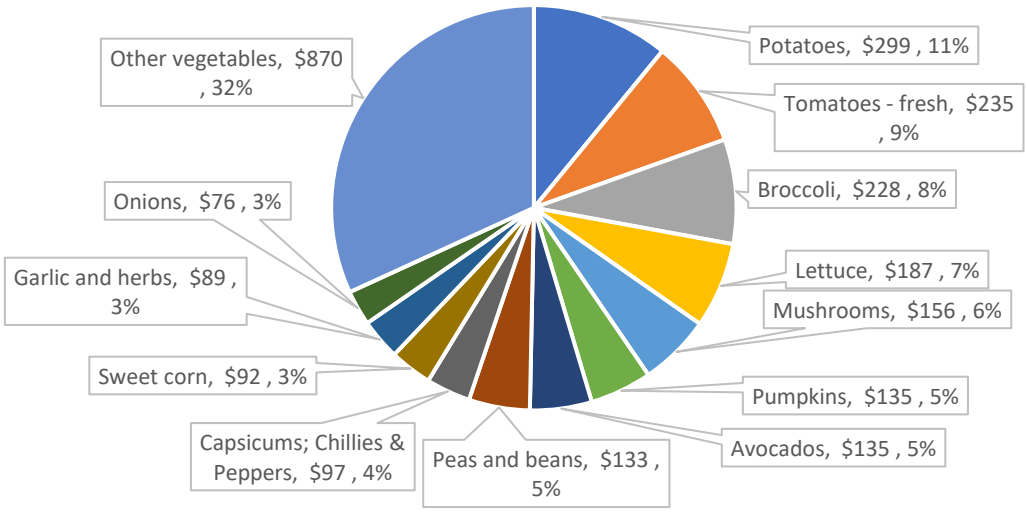


Figure 39 Commodity breakdown of farm and processing value added for the Optimal scenario in 2030 ($ million)

4.5 Part 4. Total costs and benefits

4.5.1 Intervention costs

The costs associated with delivering the Program (research, pilot, full scale implementation) were informed by consultation with the FVC and project stakeholders. The costs for each scenario reflect increased resourcing availability, which in turn was assumed to result in greater capacity to achieve consumption change across the settings and cohorts.

A full breakdown of costs, including funding sources, can be found in Appendix 4C.

4.5.2 Undiscounted cashflows

The undiscounted cashflows for the intervention costs, the healthcare cost benefits (Part 2), and supply chain benefits (Part 3) are shown in Table 19.

Table 19 Undiscounted cashflows for costs and benefits ($m)

Year ending 30 June	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
Low cost/impact																					
Intervention costs	0	23	17	49	49	34	34	29	24	14	14	14	14	14	14	14	14	14	14	14	14
Healthcare benefits	0	1	19	26	55	141	147	152	158	163	169	175	180	186	191	197	202	207	213	218	223
Supply chain benefits	0	0	20	32	66	173	184	188	193	204	208	212	224	228	233	238	251	257	263	269	284
	0	1	39	58	121	314	330	340	351	367	377	387	404	414	424	435	453	465	476	487	507
Mid cost/impact																					
Intervention costs	0	50	54	171	186	118	133	43	35	20	20	20	20	20	20	20	20	20	20	20	20
Healthcare benefits	0	5	64	66	273	523	544	566	588	609	631	652	674	695	717	738	759	779	800	820	840
Supply chain benefits	0	5	77	80	350	712	744	778	804	830	863	888	922	948	975	1,005	1,047	1,081	1,115	1,150	1,186
	0	9	141	146	622	1,234	1,289	1,344	1,391	1,439	1,494	1,540	1,596	1,644	1,692	1,743	1,806	1,860	1,914	1,970	2,026
High cost/impact																					
Intervention costs	0	73	73	271	256	239	224	57	47	27	27	27	27	27	27	27	27	27	27	27	27
Healthcare benefits	0	15	153	160	945	1,569	1,636	1,702	1,770	1,836	1,903	1,971	2,038	2,106	2,173	2,239	2,304	2,368	2,433	2,496	2,559
Supply chain benefits	0	28	272	281	2,053	4,008	4,186	4,369	4,549	4,725	4,908	5,073	5,264	5,439	5,620	5,816	6,027	6,225	6,419	6,622	6,854
	0	43	425	441	2,997	5,577	5,821	6,071	6,319	6,561	6,812	7,044	7,302	7,544	7,793	8,054	8,331	8,593	8,851	9,118	9,414
Optimal																					
Intervention costs	0	201	174	211	206	182	134	43	35	20	20	20	20	20	20	20	20	20	20	20	20
Healthcare benefits	0	14	144	434	1,137	1,337	1,384	1,431	1,478	1,524	1,569	1,615	1,660	1,704	1,749	1,792	1,835	1,876	1,917	1,956	1,995
Supply chain benefits	0	21	256	828	2,603	3,198	3,298	3,413	3,511	3,614	3,710	3,803	3,901	3,998	4,098	4,208	4,312	4,419	4,537	4,645	4,757
	0	35	400	1,261	3,740	4,535	4,682	4,844	4,989	5,138	5,280	5,418	5,561	5,702	5,847	6,001	6,147	6,294	6,454	6,601	6,752

4.5.3 Discounted cashflows

A 5% real (inflation adjusted) discount rate was applied to the undiscounted cashflows in Table 19 to quantify the present value of costs (PVC) and present value of benefits (PVB) for each scenario. These were then used to calculate the impact of each scenario using the standard impact metrics: net present value (NPV) and benefit cost ratio (BCR).

The scenario impacts up to and including 2029-30 is presented in Table 20 reflecting the point at which the interventions reach full rollout and reach.

Table 20 Scenario impact metrics up to and including 2029-30

Scenario	PVC $m	PVB $m	NPV $m	BCR $m
Low cost/impact	163	646	483	3.96
Mid cost/impact	590	2,575	1,985	4.37
High cost/impact	890	11,415	10,525	12.83
Optimal	899	11,057	10,158	12.30

The scenario impacts up to and including 2043-44 is presented in Table 21 reflecting the ongoing growth in national vegetable consumption resulting from population growth and continued flow through effects as age groups are exposed to additional intervention settings.

Table 21 Scenario impact metrics up to and including 2043-44

Scenario	PVC $m	PVB $m	NPV $m	BCR $m
Low cost/impact	280	3,535	3,256	12.64
Mid cost/impact	729	14,073	13,344	19.30
High cost/impact	1,111	64,175	63,064	57.77
Optimal	1,067	50,963	49,895	47.75

4.5.4 Comparison with previous research

In 2018 McKINNA *et al* and The CIE estimated the implications of increased vegetable demand for grower income to build the business case for the introduction of an industry marketing levy (through the vegetable R&D levy project VG17013). Scenarios were developed to illustrate the potential response in grower income relative to marketing investment driving vegetable consumption. The analysis found that for the highest scenario, an increase of 0.5 serve over an 11-year period to 2029-30 would generate a cumulative farm income increase of $1.2 billion by 2029-30.

While the McKINNA *et al* study also used The CIE HiLink model, economic benefits were only estimated at the farmgate, and not across the entire supply chain (wholesale, transport & distribution, retail & foodservice). Therefore, the results provided through the current approach provide a more comprehensive coverage of the total supply chain benefit expected from increasing vegetable consumption.

4.6 Part 5. Conclusions

Module 4 'Impact Modelling' sought to quantify the expected economic and social impact of increasing vegetable consumption through delivery of the *Plus One Serve of Vegetables by 2030* (Plus One Serve) Program. Compared to previous analysis (Deloitte 2016), this analysis incorporated some important differences in focus and method:

- A more granular approach to estimating healthcare impacts by breaking down CVD into three underlying components (CHD, stroke and other CVD)
- The addition of Type 2 diabetes as a health condition associated with vegetable consumption.
- A new revised approach to quantifying the reduction in disease risk.
- A whole of supply chain and partial equilibrium approach to estimating the economic impacts.

Through the above approach, the analysis has provided a robust estimate of the healthcare and supply chain benefits from increased vegetable consumption. The impact assessment process quantified both the benefit of reduced healthcare costs ($1.38 billion) and supply chain economic benefits ($3.30 billion) resulting from an increased per capita consumption of vegetables of one serve by 2030 through the Optimal scenario. These economic benefits will be supported by an additional 12,841 jobs added directly across vegetable production. After factoring in program delivery costs, the Optimal scenario will generate a total NPV of $10.2 billion to 2029-30, with a benefit cost ratio of 12.3:1.

The analysis has shown that any initiative to build domestic demand through preference changes linked to improved health outcomes will result in substantial and enduring benefits to the vegetable industry as demonstrated by these results. Further, the direct benefits of additional expenditure will be shared between the retail sector (higher levels of in-store turnover) and levy payers in the farming sector.

Through the delivery of Module 4, several data gaps and modelling limitations remained, which could be addressed in future research. These limitations should be considered when interpreting results.

4.6.1 Limitations of the analysis

Limitations relating to intervention outcomes in a program context

Consumption change data collected through the Rapid Review (Module 1) did not distinguish between settings delivered in isolation or those delivered through a program of complimentary settings. As such, assumptions were made in this analysis regarding the potential for higher consumption change to be achieved through the delivery of complimentary interventions that are delivered concurrently or sequentially. These assumptions could be tested through an appropriate intervention program, with the results incorporated into the modelling to provide a more robust approach.

Limitations relating to consumption change in a whole of diet context

A key limitation of the analysis relates to the consideration of the whole of diet effects of increased vegetable consumption. While this analysis focussed on the direct implications of vegetable consumption on health, and the direct implications of vegetable consumption on the vegetable supply chain, the expectation is that increased vegetable consumption will result in a decrease in consumption of substitute foods. Substitute foods may include dairy, meat, grains, fruits, seafood, and discretionary snacks depending on the intervention setting, age-group and meal occasion. Some of the implications of this substitution effect are outlined below, along with other limitations identified for this analysis.

Limitations relating to healthcare cost impacts

- While the analysis drew on available literature regarding the influence of vegetable consumption on health conditions, the quantified benefits were limited by the availability of dose-response studies. Other potential healthcare implications include obesity related health conditions (such as knee and joint health) and mental health conditions (Appleton et al. 2023). Future analysis could include these conditions once dose-response data becomes available.
- Fruit and vegetable intake is often associated with other lifestyle factors such as lower prevalence of smoking, less overweight and obesity, higher physical activity and lower intakes of alcohol and red and processed meat (Aune et al 2017). Some of the underlying studies included in the meta-analyses adjusted for these other factors,

with the results seeking to identify the health implications of vegetable consumption changes in isolation. Given the potential for increased vegetable consumption to support broader whole of diet and lifestyle changes, there is potentially further upside to the healthcare benefits identified in this analysis.

- Considering the whole of diet implications of increased vegetable consumption on healthcare costs would potentially result in benefits larger than that quantified in this analysis. This could be investigated through future research through a whole of diet modelling approach.

Limitations relating to supply-chain economic impacts

- The analysis quantified the supply chain economic benefit for vegetable growers, communities, and vegetable specific supply chain partners; however, reduced consumption and demand for substitute foods has the potential for negative economic outcomes that could offset the benefits to the vegetable supply chain. The scale of economic impact for other foods will depend on the specific economic conditions for that industry including the ability to find alternative markets (such as export markets), which provide support to existing export oriented industries such as meat and grains, but provide a potential barrier to industries with lower export levels such as some fruits.
- It is uncertain if increased vegetable consumption in a whole of diet context would result in higher or lower economic benefits. This could be investigated through future research using a whole of diet modelling approach that captures all economic trade-offs for different food groups.
- George to include point on modelling only reflecting the direct impacts.

Limitations relating to supply-chain environmental impacts

- Increased vegetable consumption in isolation results in increased vegetable production or imports, with associated increases in water, land, and energy use.
- However, as with healthcare and supply-chain implications, a whole of diet analysis would also consider the environmental implications of the reduced consumption of substitute foods.
- Previous studies (for example see Lynch et al 2018) highlighted the environmental benefits of a plant-based diet with regards to land use, water use, energy use and aggregate greenhouse gas emissions, particularly with regards to animal proteins
- It is uncertain if increased vegetable consumption in a whole of diet context would result in higher or lower environmental benefits. This could be investigated through future research using a whole of diet modelling approach that incorporates trade-offs between vegetables and other foods, and which incorporates environment outcomes for land use, water use, energy use, and aggregate greenhouse gas emissions for each food group.

4.7 Part 6. Recommendations

The modelling approach undertaken through Module 4 provided a robust foundation to estimate the potential impact of the Plus One Serve Program. In support of broader monitoring and evaluation of ongoing Program delivery, undertaking additional assessment will ensure that actual impacts can be validated.

To strengthen the capacity to undertake future impact assessment, several recommendations were identified which primarily focus on improving data regarding the benefits of increased vegetable consumption. Some of these recommendations could be supported through monitoring and evaluation of Program interventions, while others will require additional research beyond the scope of the Plus One Serve Program.

Recommendation 1: Understanding whole-of-diet substitution

The design of settings-based intervention projects should seek to measure substitution effects as a result of increased vegetable consumption. This will facilitate a more precise calculation of supply chain economic benefits and environmental benefits considering the net change in food demand.

Recommendation 2: Measurement of Program delivery effect

Measuring the extent to which program coordination can amplify the outcomes of individual settings based interventions compared to standalone, discrete intervention delivery will provide a more precise understanding the benefit of a program approach provides for realising behavioural outcomes.

Recommendation 3: Consumption change over time

The multi-year delivery Program timeframe should be leveraged to further understand the timeframe for achieving maximum consumption change relative to intervention exposure and whether this change reverts back to a steady state level. These behavioural dynamics have implications for the measurement of program impacts and are poorly understood given the short-term nature of past interventions.

Recommendation 4: Expand health benefits of Program delivery effect

Links between vegetable consumption and healthcare outcomes were not available for all diseases. Further research into the potential for increased vegetable consumption to reduce the disease burden for a wider range of health conditions, such as mental health, would support a more precise estimate of the health impacts attributable to increased vegetable consumption.

5 Conclusion and key recommendations

Module 1: Rapid review of global best practice

1. There was most evidence from systematic reviews of interventions in schools, at home or in mixed settings, and a lack of reviews that quantified the impact of interventions on vegetable intake in the retail setting, or through food service and food relief programs.

2. The average increase in vegetable consumption across all settings was + 0.12 serves per day, but up to + 0.4 serves achievable in the home or school setting. Based on the available evidence, achieving "Plus One Serve by 2030" will require a concentrated effort across multiple settings and intervention strategies.

Vegetable industry stakeholders should note that there is a relatively low number of studies that measure outcomes in the form serves of vegetables per day. Systematic reviews are required within settings to gather further evidence of the effectiveness of interventions in increasing vegetable intake.

Module 2: A proposed new methodology to quantify baseline vegetable consumption in Australia

3. A new vegetable consumption baseline methodology based on actual production, consumption and waste data was shown to be feasible.

4. The top-down (production minus waste) and bottom-up (purchasing minus waste) methods reconciled in a satisfactory way to provide confidence in the new-base calculations.

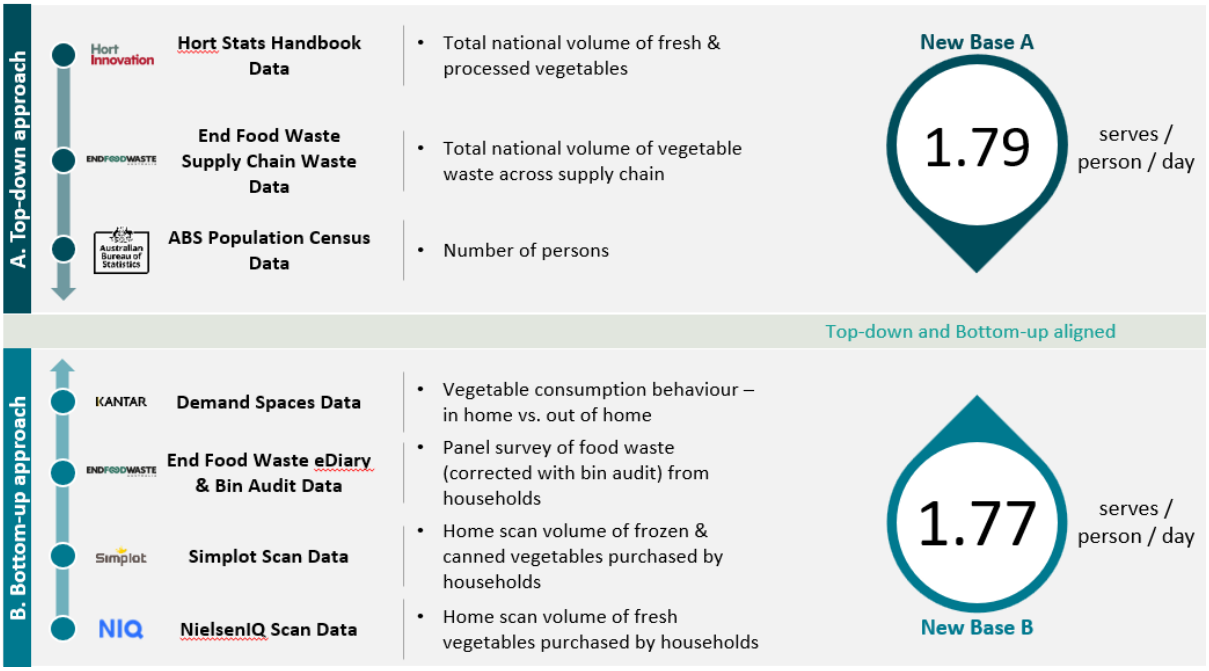


Figure 40 Reconciliation between top-down and bottom-up methods to approximate vegetable consumption

5. The new-base methodology found that the current consumption baseline was 1.8 serves per person per day (lower than the previous estimate of 2.4 serves per day). This new figure, along with a detailed breakdown into fresh and processed vegetables going to Retail and Food Services, formed part of the inputs of the Economic Impact Assessment via the Hi-Link model outlined in this report. It is recommended that the industry adopts this new methodology as its formal baseline of vegetable consumption.

6. It is possible to replicate the new baseline methodology quickly and easily e.g. annually - using data already available to the industry bodies. This would provide a consistent means of measuring changes in consumption levels towards 2030. This should account for positive impacts on vegetable consumption from the One Serve

program and changes to vegetable waste. More work is required on out-of-home settings (see separate recommendation).

7. Updating the baseline requires annual update of all datasets used in the top-down bottom-up modelling approach. To improve the current analysis, updated datasets must be provided in a granular (i.e. household-level) format where available. Additional desirable metrics such as monthly aggregates would also allow time-series analysis, which enables normalization of seasonality effects and isolate the genuine impact of interventions.

8. It is recommended the horticulture industry review its data requirements and agreements to include data for the new-base methodology.

9. Key elements of the One Serve program plan to focus on out-of-home settings. There are currently no data systems in place for out-of-home settings that can inform a granular baseline. It is recommended that industry considers further work as outlined below
    d. Finalising data models for educational, food service settings that provide a repeatable and cost-effective vegetable consumption baseline calculation, enabling regular updates to vegetable consumption data. This model would consider factors like canteen offerings, lunchbox waste, demographics, and seasonal variations.
    e. Expanding data access by partnering with existing organisations such as food service providers, catering companies, educational networks, and research institutions. Where gaps exist, designing surveys or new data collection methods to capture essential insights into consumption and waste patterns.
    f. Creating sector-specific data models for Early Learning, Primary, Secondary, Tertiary, food service sectors, incorporating geographic and economic factors. Integrate this data into the national database and reporting dashboard, aligning with insights from home and retail settings, and automate data transfer processes where possible.

There are several recommendations for industry relating to: the adoption of a new baseline methodology; the regular update of data sets; undertaking further ethnographic consumer research and updating waste data; leveraging partnerships and technology to measure vegetable intake and waste across all settings; and revising vegetable industry syndicated data needs for the new baseline approach.

Module 3: Plus One Serve Investment Scenarios

Part A: Behavioural intervention framework

10. The framework summarised below is recommended for the Plus One Serve initiative.

11. The framework is a robust tailored framework to guide interventions to increase veg consumption that through evaluation will positively contribute to the achievement of “Plus One Serve” by 2030.

12. Evidence consistently shows its success is how well the framework is used and the way that the interventions across all categories are curated, evaluated, evolved and consistently supported over time. In Melbourne it took 7 years of consistent interventions and support to establish a new lower base line of per water capita consumption – 100 litres less per day that remains 17 years later even with over 1 million more people, demonstrating generational change and stronger valuing of water in the community. It is the same for other programs we have been involved in road safety, smoking cessation, women’s activity rates, workplace safety, salmon consumption.

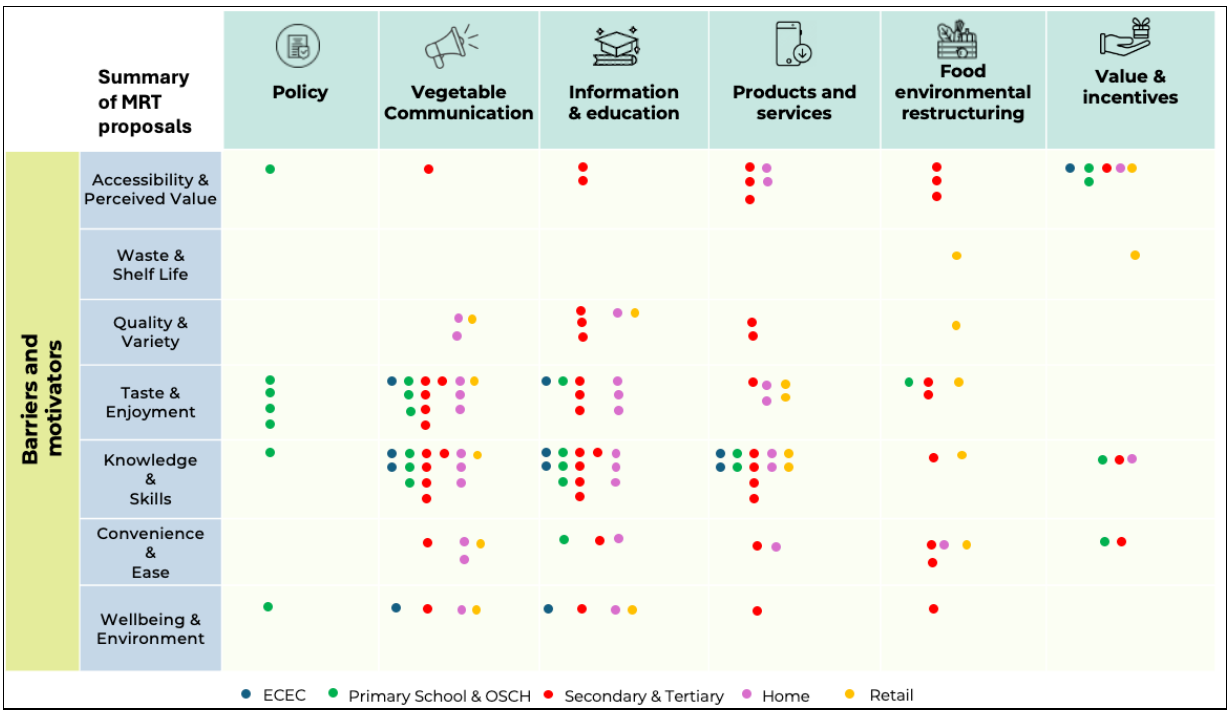


Figure 41 VG23005 'Plus One' Behavioural Intervention Framework

A top-down approach (evidence-based and expertly advised through a collaborative co-design process) has been taken to develop the national intervention framework. A test and learn approach is proposed for the Plus One Serve program, with successful interventions to be upscaled for national rollout.

The future investment scenarios (Part B) include a significant component of communication and marketing investment to drive awareness and on-going messaging for the National behaviour change campaign.

Part B: Future investment scenarios

13. An approximate 274 percent increase on current investment is estimated to be required to increase Australian vegetable consumption from an average 1.8 serves per person per day to 2.8 serves per person per day by 2030.
14. This study proposes that the most efficient way to achieve this is by prioritising investment in retail and the home setting where reach is close 90-95% of all Australians as well as growing investment in education settings.
15. Achieving Plus One Serve will require an estimated additional investment of $1.168b over a six-year period from 2025 to 2030.
16. Sustained changes to Australian's relationship with vegetables is proposed to start where food is purchased by addressing consumer misconceptions that vegetables are too expensive, might be wasted or are too difficult to prepare.
17. The key to success starts with generational change from the home through to children in education settings where healthy eating can be reinforced to build life-long vegetable eating habits.

The portfolio of projects modelled in the optimal scenario is a new combination of structural interventions e.g. initiatives to improve value perception in retail, and other behavioural change methods. In other words, this is a collaborative cross-sector national program with new approaches that have not been tried before.

A multi-layered co-investment model is needed to fund the national behaviour change programme - spanning government, industry and business. This investment will be in the form of policy change, restructuring of environments, and delivery of community-based programmes.

Whilst the value of investment is high, it is to be noted this is spread across sectors, stakeholders, initiatives and includes structural change. This scenario is modelled to deliver a significant return to industry, business and the community.

Critical to achieving Plus One Serve by 2030 is priority focus on investment in Retail and Home settings in years 1 to 3.

Module 4: Economic Impact Assessment

Impact modelling describes that by 2030 increasing vegetable consumption by one serve per person per day is represents a:

18. 56% increase in consumption compared to the modelled national baseline of 1.8 serves per person per day.

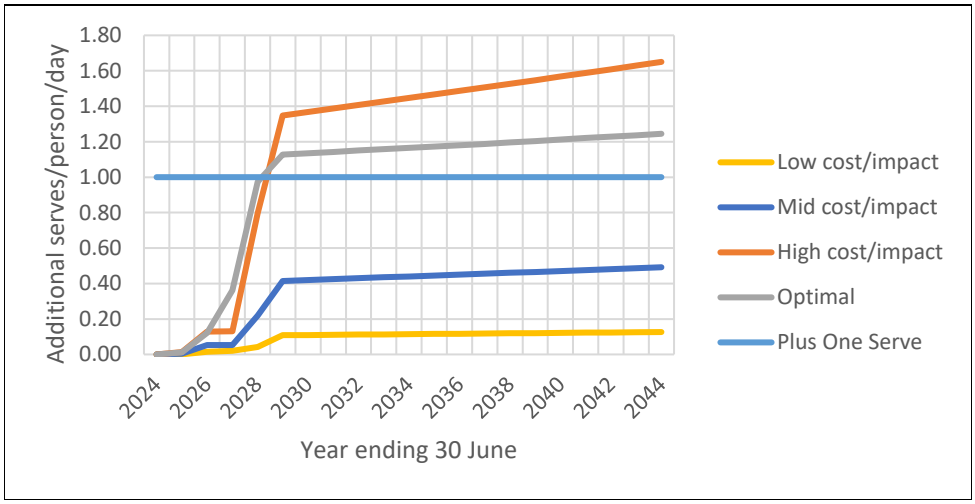


Figure 42 Additional serves per person per day from the baseline

19. $1.38 billion decrease in healthcare costs from reduced health risk associated with cardiovascular disease, cancer and type 2 diabetes.
20. $3.30 billion net supply chain economic benefit distributed across the vegetable growing regions and along the vegetable supply chain from growers to retailers.
    a. The farm/processing sector will generate the majority of benefit ($2.73 billion).
21. $12.30 return for every $1 invested.
22. 12,841 jobs added across vegetable production regions.

The modelling demonstrates that the target of adding a serve of vegetables to Australian diets by 2030 is feasible with high return on investment. However, it should be noted that the dietary change is significant and achieving the target intake requires national cross-sector collaboration and investment.

In closing:

VG23005 has successfully provided the launch pad for a national behaviour change program that will drive an increase in Australian vegetable consumption by one serve per person per day by 2030.

This project has gathered global evidence on vegetable intake interventions and their impact within settings. A new approach to measuring the national baseline has been developed, with the scenario modelling and optimal investment approach demonstrating that a national behaviour change program to increase vegetable consumption will deliver significant benefits to industry, the economy, and improve the health and wellbeing of all Australians.

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7 Appendices

7.1 Appendix – Module 1

Appendix 1A

Cochrane rapid review methods guidance

Table 22 Updated guidance on methods used in Cochrane rapid reviews of effectiveness

Recommendations	Recommendation followed?
Topic refinement: Setting the research question	
1 Involve knowledge users to set and refine the review question, eligibility criteria, and outcomes of interest, with consultation at various stages of the review	✓
2 Develop a protocol that includes the review questions, population, interventions, comparators, outcomes, and methods of conducting the review	✓
Topic refinement: Setting the eligibility criteria	
3 Clearly define the eligibility criteria, including any restrictions or limits:	✓
3.1 Limit the number of interventions and comparators	✓
3.2 Limit the number of outcomes, focusing on those most important for decision making	✓
3.3 Consider restriction of the search date of the evidence base, with clinical or methodological justification provided	✓
3.4 Limit the setting, with clinical or methodological justification provided	✓
3.5 Limit the publication language to English at study selection, with other languages added when relevant	✓
3.6 Prioritise the inclusion of high quality study designs relevant to the review question or objective	✓
Searches	
4 Involve an information specialist to develop the search strategy and to consider search methods, resources, and search limits	✓
5 Select a small number (but at least two) bibliographic databases that are likely to retrieve relevant literature For rapid reviews focused on randomised controlled trials only: • Use a combination of two of the following databases (if you have access): Medline, CENTRAL, and Embase	✓
For other rapid reviews that include non-randomised studies:	✓

Recommendations	Recommendation followed?
• Database selection should be carefully considered for rapid reviews depending on available time and resources. In many cases, Medline will be the most relevant database, but this is not always the case.1043 A search of specialised databases (eg, CINAHL, PsycInfo, ERIC) may be necessary for specialised review topics (eg, the use of CINAHL for rapid reviews related to nursing care, PsycInfo for rapid reviews related to mental health, or ERIC for rapid reviews related to educational interventions)	
6 Use the PRESS checklist to peer review the primary search strategy If use of PRESS is not possible, at a minimum search strategies should be double checked for typographical errors, missed key words, and overall structure	X
7 Assess the need for grey literature and supplemental searching. Justify the sources to be searched	✓
Study selection	
Screening of title and abstract and of full text 8 Employ piloting exercises at abstract and full text screening levels to allow team members to test the study selection process on a selective sample of records to ensure that all team members apply a consistent approach to screening	✓
9 Conduct dual and independent screening of a proportion of records (eg, 20%) and assess reviewer agreement—if agreement is good (eg, κ is ≥0.8), proceed with single screening	✓
Data extraction	
10 Limit data extraction to only the most important data fields relevant to address the review question	✓
11 For data extraction, employ a piloting exercise to allow team members to test this task on a small proportion of records to ensure that all team members perform it consistently and correctly	✓
12 Have one person extract the data, and for critical data that can affect the results or conclusions, have a second person verify the data for accuracy and completeness	✓
13 When available, extract data directly from existing systematic reviews rather than from primary studies	✓
Risk of bias assessment	
14 Use validated and study design specific tools to assess the risk of bias of included studies	✓
15 Focus the risk of bias assessment at least on the most important outcomes	✓
16 Have one person perform the risk of bias assessment and a second person to verify the judgements	✓
Synthesis	

Recommendations	Recommendation followed?
17 Provide a descriptive summary of the included studies	✓
18 Provide a synthesis of the findings	✓
19 Consider a meta-analysis if appropriate and resources permit	n/a
20 Consider how to synthesise evidence when including one systematic review or more	✓
Certainty of evidence	
21 Use the GRADE approach to assess the certainty of evidence if time and resources allow	X
22 Limit the certain of evidence ratings to the main intervention and comparator, and focus on critical outcomes only	n/a
23 Have one person complete the GRADE assessment and a second person to verify assessments	n/a
Other best practice considerations	
24 Provide a clear description of the selected review approach, which includes outlining the restricted methods used. Additionally, discuss the potential limitations of these chosen methods and how they may influence the interpretation of the research findings	✓

• It is advisable that rapid reviews are led only by experienced systematic reviewers
• Rapid reviews should be preceded by a protocol. For Cochrane rapid reviews, protocols should be submitted to, and approved by, Cochrane
• Register the protocol on a publicly available platform (eg, PROSPERO, Open Science Framework), or for Cochrane rapid reviews on Cochrane
• Allow for changes to the protocol, as rapid reviews involve an iterative process
• Document all post hoc changes
• Incorporate the use of systematic review software to streamline the process
• Apply appropriate reporting guidelines:
  • PRISMA-P for the rapid review protocol
  • PRISMA-S for the search strategies
  • PRISMA for the rapid review publication or report	

CENTRAL=Central Register of Controlled Trials; CINAHL=Cumulative Index to Nursing and Allied Health Literature; PRESS=Peer Review of Electronic Search Strategies; ERIC=Education Resources Information Center; GRADE=Grading of Recommendations Assessment, Development and Evaluation; PRISMA=Preferred Reporting Items for Systematic Review and Meta-Analysis.

To be considered a systematic review for screening purposes, studies should clearly report inclusion or exclusion criteria, or both; search at least two databases; conduct risk of bias assessment; and provide a list and synthesis of included studies.

Appendix 1B

Study protocol

Overview

We will undertake a rapid review of the best available published evidence on initiatives to increase vegetable intake. The review will cover a broad range of initiatives delivered across various settings. Recommendations on the target population and the range in magnitude of effect of the identified intervention strategies will be summarised by setting. The review may be supplemented with evidence from evaluation reports of key national and international vegetable focused programs, as identified by the project team and FVC Research Committee. It is expected the findings will be used to inform scenarios for a modelling exercise to explore the potential impact of implementing setting-based initiatives to increase vegetable intake within the Australian population.

Deliverables include:

• Final report with summary of evidence-based initiatives with indications of the target population, setting and potential impact on vegetable intake.

• Engagement with FVC Research Committee, FVC Executive and broader project consultants.

Methodology for rapid review

We will conduct a rapid review guided by the Cochrane Rapid Review method, with consideration of the SelecTing Approaches for Rapid Reviews (STARR) approach. A more detailed description of the method is in Table 4 of Appendix 2.7.

Briefly, there are four key steps:

1. Refine the research question, PICO, inclusion/exclusion criteria, and outcomes of interest. Consult with stakeholders to ensure the question is fit for purpose and scope is focused and contained.
2. Develop, trial and seek feedback on the search strategy, conduct the search in a limited number of selected databases (PubMed and 1-2 additional specialised databases if needed).
3. Undertake screening of articles, data extraction and risk of bias assessment using a validated tool.
4. Prepare a summary table of intervention strategies by setting focussed on the target population and the range in the magnitude of change in vegetable intake.

Through the search, we will identify the most recent umbrella reviews or in the absence of this, high-quality systematic reviews across the settings of interest.

The setting of interest are:

1. Early Childhood Education and Care
2. Primary schools & OSHC
3. Secondary & tertiary education
4. Home-based
5. Retail food environments
6. Workplace
7. Foodservice – Institutional and commercial
8. Aged Care – In home and/or facility
9. Food Relief

The aim will be to identify at least one high quality review (umbrella or systematic review) for each setting, as well as consider landmark reviews (as identified by the project team in consultation with the FVC Research Committee). If a high-quality review is not available for a setting of interest, then we will consider the inclusion of a lower quality systematic review. Data extraction will focus on the target population of the initiatives and estimates of the magnitude of change in vegetable intake.

Evidence from the reviews may be supplemented with evidence from evaluation reports of key national and international vegetable focused programs – as identified by the project team and FVC Research Committee. It is envisaged that around 20 intervention settings/strategy approaches will be described.

Findings will be combined into a summary table that reports the high-level results across priority settings and strategies, focused on the population of interest and magnitude of effect, that is change in vegetable intake. Table 1 shows the proposed format for the summary of evidence. The summary table will be shared with the FVC Research Committee for input and approval. The summary of evidence will be discussed with and made available to the other delivery partners to model how a plus one serve may be achieved through intervention across a variety of settings. A more detailed methodology is described below the timeline.

Description of method

Research Question: Using the highest quality evidence available, what is the expected change in vegetable intake observed in various settings as a result of intervention initiatives?

Eligibility criteria

Criteria	Inclusion	Exclusion
Population	Humans (including children and adults)	• Infants (<2y) • Animals • Population sub-groups selected on the basis of pre-existing comorbidities (e.g. those with type 2 diabetes, hypertension or cancer); reviews focused on strategies that targeted the treatment or management of eating disorders (e.g. anorexia nervosa or bulimia), malnutrition or other diseases
Intervention /Exposure	a. Interventions that aimed to increase vegetable intake (in isolation or in combination with a healthy diet). Interventions can be administered in physical settings or online (e-health) *Note*: can include vegetable juice	• First introduction to vegetables (i.e., weaning studies for infants)
Comparator	No restrictions	
Outcome	• Quantified measure of vegetable intake (e.g., serves, portions, or grams/day); or • Purchase data, as a proxy for intake (for retail settings only). Measures can be objective (e.g., intake via weighed food record; purchase via sales data) or self-reported measure (e.g., intake via food frequency questionnaire; purchase via purchase behaviour) *Note:* where reviews include both fruit & vegetable intake, data must be reported on vegetables separately to be eligible for inclusion	• Hypothetical choice • Consumption intentions • Health outcomes (e.g., weight change, disease risk) • Overall diet quality • Attitudes (e.g., preference/liking), knowledge, skills, access
Context	• Early Childhood Education and Care • Primary schools & OSHC • Secondary & tertiary education	• Laboratories or other simulated contexts

	• Home-based • Retail food environments – e.g., supermarkets, grocery stores, canteens, cafeterias • Workplace • Foodservice – Institutional • Foodservice – Commercial • Aged Care – In home and/or facility • Food Relief	
Study design	• Umbrella reviews • Systematic reviews • Meta-analyses	• Primary research articles • Opinion or perspective pieces • Narrative or scoping reviews • Protocol papers

Restrictions (/filters):

a. Date – Reviews published in the past 10 years (i.e., in or after 2014)

b. Language – published in English

c. Study design – reviews

d. Population – human NOT animal

Appendix 1C

PRIOR checklist

Table 23 PRIOR checklist (preferred reporting items for overviews of reviews)

Section topic	Item No	Item	Location where item is reported
Title			
Title	1	Identify the report as an overview of reviews.	✓
Abstract			
Abstract	2	Provide a comprehensive and accurate summary of the purpose, methods, and results of the overview of reviews.	n/a
Introduction			
Rationale	3	Describe the rationale for conducting the overview of reviews in the context of existing knowledge.	✓
Objectives	4	Provide an explicit statement of the objective(s) or question(s) addressed by the overview of reviews.	✓
Methods			
Eligibility criteria	5a	Specify the inclusion and exclusion criteria for the overview of reviews. If supplemental primary studies were included, this should be stated, with a rationale.	✓
	5b	Specify the definition of “systematic review” as used in the inclusion criteria for the overview of reviews.	✓
Information sources	6	Specify all databases, registers, websites, organisations, reference lists, and other sources searched or consulted to identify systematic reviews and supplemental primary studies (if included). Specify the date when each source was last searched or consulted.	✓
Search strategy	7	Present the full search strategies for all databases, registers and websites, such that they could be reproduced. Describe any search filters and limits applied.	✓
Selection process	8a	Describe the methods used to decide whether a systematic review or supplemental primary study (if included) met the inclusion criteria of the overview of reviews.	✓
	8b	Describe how overlap in the populations, interventions, comparators, and/or outcomes of systematic reviews was identified and managed during study selection.	X
Data collection process	9a	Describe the methods used to collect data from reports.	✓

Section topic	Item No	Item	Location where item is reported
	9b	If applicable, describe the methods used to identify and manage primary study overlap at the level of the comparison and outcome during data collection. For each outcome, specify the method used to illustrate and/or quantify the degree of primary study overlap across systematic reviews.	n/a
	9c	If applicable, specify the methods used to manage discrepant data across systematic reviews during data collection.	n/a
Data items	10	List and define all variables and outcomes for which data were sought. Describe any assumptions made and/or measures taken to identify and clarify missing or unclear information.	✓
Risk of bias assessment	11a	Describe the methods used to assess risk of bias or methodological quality of the included systematic reviews.	✓
	11b	Describe the methods used to collect data on (from the systematic reviews) and/or assess the risk of bias of the primary studies included in the systematic reviews. Provide a justification for instances where flawed, incomplete, or missing assessments are identified but not reassessed.	✓
	11c	Describe the methods used to assess the risk of bias of supplemental primary studies (if included).	n/a
Synthesis methods	12a	Describe the methods used to summarise or synthesise results and provide a rationale for the choice(s).	✓
	12b	Describe any methods used to explore possible causes of heterogeneity among results.	n/a
	12c	Describe any sensitivity analyses conducted to assess the robustness of the synthesised results.	n/a
Reporting bias assessment	13	Describe the methods used to collect data on (from the systematic reviews) and/or assess the risk of bias due to missing results in a summary or synthesis (arising from reporting biases at the levels of the systematic reviews, primary studies, and supplemental primary studies, if included).	n/a
Certainty assessment	14	Describe the methods used to collect data on (from the systematic reviews) and/or assess certainty (or confidence) in the body of evidence for an outcome.	X
Results			
Systematic review and supplemental primary study selection	15a	Describe the results of the search and selection process, including the number of records screened, assessed for eligibility, and included in the overview of reviews, ideally with a flow diagram.	✓
	15b	Provide a list of studies that might appear to meet the inclusion criteria, but were excluded, with the main reason for exclusion.	X

Section topic	Item No	Item	Location where item is reported
Characteristics of systematic reviews and supplemental primary studies	16	Cite each included systematic review and supplemental primary study (if included) and present its characteristics.	✓
Primary study overlap	17	Describe the extent of primary study overlap across the included systematic reviews.	X
Risk of bias in systematic reviews, primary studies, and supplemental primary studies	18a	Present assessments of risk of bias or methodological quality for each included systematic review.	✓
	18b	Present assessments (collected from systematic reviews or assessed anew) of the risk of bias of the primary studies included in the systematic reviews.	X
	18c	Present assessments of the risk of bias of supplemental primary studies (if included).	n/a
Summary or synthesis of results	19a	For all outcomes, summarise the evidence from the systematic reviews and supplemental primary studies (if included). If meta-analyses were done, present for each the summary estimate and its precision and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	✓
	19b	If meta-analyses were done, present results of all investigations of possible causes of heterogeneity.	n/a
	19c	If meta-analyses were done, present results of all sensitivity analyses conducted to assess the robustness of synthesised results.	n/a
Reporting biases	20	Present assessments (collected from systematic reviews and/or assessed anew) of the risk of bias due to missing primary studies, analyses, or results in a summary or synthesis (arising from reporting biases at the levels of the systematic reviews, primary studies, and supplemental primary studies, if included) for each summary or synthesis assessed.	n/a
Certainty of evidence	21	Present assessments (collected or assessed anew) of certainty (or confidence) in the body of evidence for each outcome.	X
Discussion			
Discussion	22a	Summarise the main findings, including any discrepancies in findings across the included systematic reviews and supplemental primary studies (if included).	✓
	22b	Provide a general interpretation of the results in the context of other evidence.	✓
	22c	Discuss any limitations of the evidence from systematic reviews, their primary studies, and supplemental primary studies (if included) included in the overview of reviews. Discuss any limitations of the overview of reviews methods used.	✓

Section topic	Item No	Item	Location where item is reported
	22d	Discuss implications for practice, policy, and future research (both systematic reviews and primary research). Consider the relevance of the findings to the end users of the overview of reviews, eg, healthcare providers, policymakers, patients, among others.	✓
Other information			
Registration and protocol	23a	Provide registration information for the overview of reviews, including register name and registration number, or state that the overview of reviews was not registered.	X
	23b	Indicate where the overview of reviews protocol can be accessed, or state that a protocol was not prepared.	✓
	23c	Describe and explain any amendments to information provided at registration or in the protocol. Indicate the stage of the overview of reviews at which amendments were made.	✓
Support	24	Describe sources of financial or non-financial support for the overview of reviews, and the role of the funders or sponsors in the overview of reviews.	X
Competing interests	25	Declare any competing interests of the overview of reviews' authors.	X
Author information	26a	Provide contact information for the corresponding author.	n/a
	26b	Describe the contributions of individual authors and identify the guarantor of the overview of reviews.	✓
Availability of data and other materials	27	Report which of the following are available, where they can be found, and under which conditions they may be accessed: template data collection forms; data collected from included systematic reviews and supplemental primary studies; analytic code; any other materials used in the overview of reviews.	X

Adapted from “Reporting guideline for overviews of reviews of healthcare interventions: development of the PRIOR statement” by M Gates M, A Gates A, D Pieper, et al., 2022, British Medical Journal, 378:e070849 (Gates et al., 2022).

Appendix 1D

Literature search strategy

Table 24 Search strategy used across three databases

Database searched [date]	Search Terms	Filters / Limiters applied
PubMed [15.02.2024]	((Home[Title/Abstract] OR parent*[Title/Abstract] OR family[Title/Abstract] OR "early learning"[Title/Abstract] OR community[Title/Abstract] OR Childcare[Title/Abstract] OR daycare[Title/Abstract] OR kindergarten*[Title/Abstract] OR preschool*[Title/Abstract] OR "pre-school*"[Title/Abstract] OR school*[Title/Abstract] OR classroom[Title/Abstract] OR canteen[Title/Abstract] OR afterschool[Title/Abstract] OR OSHC[Title/Abstract] OR "vacation care"[Title/Abstract] OR universit*[Title/Abstract] OR college*[Title/Abstract] OR supermarket*[Title/Abstract] OR grocer's[Title/Abstract] OR store[Title/Abstract] OR retail[Title/Abstract] OR mobile[Title/Abstract] OR online[Title/Abstract] OR m-health[Title/Abstract] OR e-health[Title/Abstract] OR app[Title/Abstract] OR "social media"[Title/Abstract] OR workplace[Title/Abstract] OR worksite[Title/Abstract] OR cafeteria[Title/Abstract] OR foodservice[Title/Abstract] OR "food service*"[Title/Abstract] OR catering[Title/Abstract] OR caterer*[Title/Abstract] OR hospital*OR gaol*[Title/Abstract] OR jail*[Title/Abstract] OR prison*[Title/Abstract] OR correctional[Title/Abstract] OR remand[Title/Abstract] OR "aged care"[Title/Abstract] OR "nursing home*"[Title/Abstract] OR "residential care"[Title/Abstract] OR charit*[Title/Abstract] OR "food relief"[Title/Abstract] OR foodbank[Title/Abstract]) OR ("Supermarkets"[Mesh] OR "Community Health Services"[Mesh] OR "Schools"[Mesh] OR "School Health Services"[Mesh] OR "Telemedicine"[Mesh] OR "Mobile Applications"[Mesh] OR "Food Services"[Mesh] OR "Correctional Facilities"[Mesh] OR "Residential Facilities"[Mesh] OR "Charities"[Mesh] OR "Workplace"[Mesh])) AND (Vegetable*[Title/Abstract] OR "Vegetables"[Mesh]) AND ((Intake[Title/Abstract] OR consumption[Title/Abstract] OR consume[Title/Abstract] OR consumed[Title/Abstract] OR eaten[Title/Abstract] OR serve[Title/Abstract] OR serves[Title/Abstract] OR serving*[Title/Abstract] OR purchas*[Title/Abstract] OR sale*[Title/Abstract] OR receipt*[Title/Abstract]) OR "Eating"[Mesh]) AND (("systematic review"[Title/Abstract] OR metanalysis[Title/Abstract] OR metanalyses[Title/Abstract] OR meta-analysis[Title/Abstract] OR meta-analyses[Title/Abstract] OR "rapid review"[Title/Abstract] OR "critically appraised topic"[Title/Abstract] OR "umbrella review"[Title/Abstract] OR handsearch[Title/Abstract] OR "hand search"[Title/Abstract] OR "data synthesis"[Title/Abstract] OR "data extraction"[Title/Abstract]) OR ("Meta-Analysis"[Publication Type] OR "Systematic Review"[Publication Type] OR "Meta-Analysis as Topic"[Mesh] OR "Systematic Reviews as Topic"[Mesh])) NOT ("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh]))	English, 2014 onwards
Web of Knowledge Core Collection [15.02.2024]	TS=((Home OR parent* OR family OR "early learning" OR community OR Childcare OR daycare OR kindergarten* OR preschool* OR pre-school* OR school* OR classroom OR canteen OR afterschool OR OSHC OR "vacation care" OR universit* OR college* OR supermarket* OR grocer's OR store OR retail OR mobile OR online OR m-health OR e-health OR app OR "social media" OR workplace OR worksite OR cafeteria OR foodservice OR "food service*" OR catering OR caterer* OR "hospital*OR gaol*" OR jail* OR prison* OR correctional OR remand OR "aged care" OR "nursing home*" OR "residential care" OR charit* OR "food relief" OR foodbank) AND Vegetable* AND (Intake OR consumption OR consume OR consumed OR eaten OR serve OR serves OR serving* OR purchas* OR sale* OR receipt*) AND ("systematic review" OR metanalysis OR metanalyses OR meta-analysis OR meta-analyses OR "rapid review" OR "critically appraised topic" OR "umbrella review" OR handsearch OR "hand search" OR "data synthesis" OR "data extraction"))	English, 2014 onwards
Cochrane Central	((Home:ti,ab OR parent*:ti,ab OR family:ti,ab OR "early learning":ti,ab OR community:ti,ab OR Childcare:ti,ab OR daycare:ti,ab OR kindergarten*:ti,ab OR preschool*:ti,ab OR pre-school*:ti,ab OR school*:ti,ab OR classroom:ti,ab OR canteen:ti,ab OR afterschool:ti,ab OR OSHC:ti,ab OR "vacation care":ti,ab OR	2014 onwards

[15.02.2024]	universit*:ti,ab OR college*:ti,ab OR supermarket*:ti,ab OR grocer's:ti,ab OR store:ti,ab OR retail:ti,ab OR mobile:ti,ab OR online:ti,ab OR m-health:ti,ab OR e-health:ti,ab OR app:ti,ab OR "social media":ti,ab OR workplace:ti,ab OR worksite:ti,ab OR cafeteria:ti,ab OR foodservice:ti,ab OR ("food" NEXT service*):ti,ab OR catering:ti,ab OR caterer*:ti,ab OR (hospital*OR NEXT gaol*):ti,ab OR jail*:ti,ab OR prison*:ti,ab OR correctional:ti,ab OR remand:ti,ab OR "aged care":ti,ab OR ("nursing" NEXT home*):ti,ab OR "residential care":ti,ab OR charit*:ti,ab OR "food relief":ti,ab OR foodbank:ti,ab) OR ([mh Supermarkets] OR [mh "Community Health Services"] OR [mh Schools] OR [mh "School Health Services"] OR [mh Telemedicine] OR [mh "Mobile Applications"] OR [mh "Food Services"] OR [mh "Correctional Facilities"] OR [mh "Residential Facilities"] OR [mh Charities] OR [mh Workplace])) AND (Vegetable*:ti,ab OR [mh Vegetables]) AND ((Intake:ti,ab OR consumption:ti,ab OR consume:ti,ab OR consumed:ti,ab OR eaten:ti,ab OR serve:ti,ab OR serves:ti,ab OR serving*:ti,ab OR purchas*:ti,ab OR sale*:ti,ab OR receipt*:ti,ab) OR [mh Eating]) AND (("systematic review":ti,ab OR metanalysis:ti,ab OR metanalyses:ti,ab OR meta-analysis:ti,ab OR meta-analyses:ti,ab OR "rapid review":ti,ab OR "critically appraised topic":ti,ab OR "umbrella review":ti,ab OR handsearch:ti,ab OR "hand search":ti,ab OR "data synthesis":ti,ab OR "data extraction":ti,ab) OR (Meta-Analysis:pt OR "Systematic Review":pt OR [mh "Meta-Analysis as Topic"] OR [mh "Systematic Reviews as Topic"])) NOT ([mh Animals] NOT ([mh Animals] AND [mh Humans]))	

Note: Date format, dd.mm.yyy.

Appendix 1E

Risk of bias assessment of included reviews

Table 25 Assessment of the risk of bias of reviews using the Risk of Bias In Systematic Reviews (ROBIS) tool

	Study eligibility criteria						Identification and selection of studies						Data collection and study appraisal						Synthesis and findings							Conclusions supported by evidence			Overall risk of bias
Author, year	1.1	1.2	1.3	1.4	1.5	Overall	2.1	2.2	2.3	2.4	2.5	Overall	3.1	3.2	3.3	3.4	3.5	Overall	4.1	4.2	4.3	4.4	4.5	4.6	Overall	A	B	C	
Appleton et al., 2018	Y	Y	Y	Y	Y	LOW CONCERN	PY	Y	PY	N	Y	LOW CONCERN	Y	Y	Y	Y	Y	LOW CONCERN	PY	Y	Y	Y	PY	PY	LOW CONCERN	Y	Y	Y	Low
Broers et al., 2017	NI	Y	PY	Y	Y	LOW CONCERN	Y	PN	PY	Y	PN	HIGH CONCERN	PY	Y	PY	Y	Y	HIGH CONCERN	Y	NI	Y	Y	PY	PY	LOW CONCERN	PN	Y	Y	High
Dabravolskaj et al., 2020	NI	Y	Y	Y	Y	LOW CONCERN	Y	PY	Y	Y	PN	LOW CONCERN	PY	Y	Y	Y	PN	LOW CONCERN	Y	NI	Y	PY	PY	PN	HIGH CONCERN	PY	Y	Y	Low
deMedeiros et al., 2022	Y	Y	Y	Y	Y	LOW CONCERN	Y	PN	PY	PY	Y	LOW CONCERN	Y	y	y	Y	Y	LOW CONCERN	PY	N	Y	PY	PN	PN	HIGH CONCERN	PY	Y	Y	Low
Diep et al., 2014	NI	Y	Y	Y	Y	LOW CONCERN	Y	Y	PN	Y	N	HIGH CONCERN	Y	Y	Y	PY	Y	LOW CONCERN	Y	NI	Y	Y	Y	Y	LOW CONCERN	PY	Y	Y	Low
Hendrie et al., 2017	NI	Y	Y	Y	PY	LOW CONCERN	PY	PN	PY	N	PN	HIGH CONCERN	PY	PY	PY	Y	PN	LOW CONCERN	Y	NI	PY	Y	Y	N	HIGH CONCERN	PY	Y	PY	Low
Jabbari et al., 2024	NI	PY	PY	PY	Y	LOW CONCERN	Y	Y	PY	N	Y	LOW CONCERN	Y	Y	Y	Y	Y	LOW CONCERN	Y	NI	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	Low
Micha et al., 2018	PY	Y	Y	PY	Y	LOW CONCERN	Y	PY	PY	Y	N	LOW CONCERN	Y	PY	Y	Y	Y	LOW CONCERN	Y	PY	Y	Y	Y	PY	LOW CONCERN	Y	Y	PY	Low
Mingay et al., 2022	Y	Y	Y	PY	Y	LOW CONCERN	Y	Y	PY	N	Y	LOW CONCERN	Y	Y	Y	Y	Y	LOW CONCERN	Y	N	Y	PY	Y	PY	LOW CONCERN	Y	Y	Y	Low
Nathan et al., 2019	Y	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	N	Y	LOW CONCERN	Y	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	Y	PN	PY	LOW CONCERN	Y	Y	Y	Low
Nekitsing et al., 2018	Y	PY	PY	Y	Y	LOW CONCERN	Y	Y	PY	N	N	HIGH CONCERN	Y	Y	Y	Y	Y	LOW CONCERN	Y	PY	Y	Y	Y	Y	LOW CONCERN	PN	Y	Y	High

	Study eligibility criteria						Identification and selection of studies						Data collection and study appraisal						Synthesis and findings							Conclusions supported by evidence			Overall risk of bias
Author, year	1.1	1.2	1.3	1.4	1.5	Overall	2.1	2.2	2.3	2.4	2.5	Overall	3.1	3.2	3.3	3.4	3.5	Overall	4.1	4.2	4.3	4.4	4.5	4.6	Overall	A	B	C	
Neves et al., 2020	Y	Y	PN	PY	Y	LOW CONCERN	Y	PN	NI	PY	Y	HIGH CONCERN	Y	Y	Y	Y	Y	LOW CONCERN	Y	N	Y	Y	Y	Y	LOW CONCERN	PN	Y	Y	High
Nour et al., 2016	Y	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	N	PN	HIGH CONCERN	Y	Y	Y	Y	Y	LOW CONCERN	Y	PY	Y	Y	Y	Y	LOW CONCERN	PY	Y	Y	Low
Nury et al., 2022	Y	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	Low
Peñalvo et al., 2021	Y	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	N	PY	LOW CONCERN	Y	Y	Y	Y	Y	LOW CONCERN	PY	PY	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	Low
Pineda et al., 2021	Y	Y	Y	Y	Y	LOW CONCERN	Y	PY	Y	PY	PN	LOW CONCERN	PN	PY	Y	PY	N	HIGH CONCERN	Y	PY	Y	Y	Y	PN	LOW CONCERN	PN	Y	Y	High
Touyz et al., 2018	PY	Y	Y	Y	PY	LOW CONCERN	Y	PY	PN	N	PN	HIGH CONCERN	PY	PY	PY	PY	PY	LOW CONCERN	PY	PY	PY	Y	PY	PY	LOW CONCERN	PN	Y	PY	High
Vaughan et al., 2024	Y	Y	PY	Y	Y	LOW CONCERN	Y	PN	Y	N	Y	HIGH CONCERN	PY	Y	PY	Y	PY	LOW CONCERN	PY	N	Y	PY	PN	Y	HIGH CONCERN	PN	Y	Y	High
Yang et al., 2023	PY	Y	Y	Y	Y	LOW CONCERN	Y	Y	PY	N	PN	HIGH CONCERN	N	Y	Y	Y	Y	LOW CONCERN	Y	N	Y	Y	Y	Y	LOW CONCERN	PY	Y	Y	Low
Yoong et al., 2023	Y	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	Y	Y	Y	LOW CONCERN	Y	Y	Y	Low

Detailed explanatory notes about the ROBIS tool: **Domain 1, Study eligibility criteria**: 1.1 Did the review adhere to pre-defined objectives and eligibility criteria?; 1.2 Were the eligibility criteria appropriate for the review question?; 1.3 Were eligibility criteria unambiguous?; 1.4 Were any restrictions in eligibility criteria based on study characteristics appropriate?; 1.5 Were any restrictions in eligibility criteria based on sources of information appropriate (e.g. publication status or format, language, availability of data?. **Domain 2, Identification and selection of studies**: 2.1 Did the search include an appropriate range of databases/electronic sources for published and unpublished reports?; 2.2 Were methods additional to database searching used to identify relevant reports?; 2.3 Were the terms and structure of the search strategy likely to retrieve as many eligible studies as possible?; 2.4 Were restrictions based on date, publication format, or language appropriate?; 2.5 Were efforts made to minimise error in selection of studies?. **Domain 3, Data collection and study appraisal**: 3.1 Were efforts made to minimise error in data collection?; 3.2 Were sufficient study characteristics available for both review authors and readers to be able to interpret the results?; 3.3 Were all relevant study results collected for use in the synthesis?; 3.4 Were efforts made to minimise error in risk of bias assessment?; 3.5

Was risk of bias (or methodological quality) formally assessed using appropriate criteria?. **Domain 4, Synthesis and findings**: 4.1 Did the synthesis include all studies that it should?; 4.2 Were all pre-defined analyses reported or departures explained?; 4.3 Was the synthesis appropriate given the nature and similarity in the research questions, study designs and outcomes across included studies?; 4.4 Was between-study variation (heterogeneity) minimal or addressed in the synthesis?; 4.5 Were the findings robust, e.g. as demonstrated through funnel plot or sensitivity analyses?; 4.6 Were biases in primary studies minimal or addressed in the synthesis?. **Domain 5, Describe whether conclusions were supported by the evidence:** 5A Did the interpretation of findings address all of the concerns identified in Domains 1 to 4?; 5B Was the relevance of identified studies to the review's research question appropriately considered?; 5C Did the reviewers avoid emphasizing results on the basis of their statistical significance?.

Appendix 1F

Effects of interventions on vegetable intake by setting – primary and secondary analyses

Table 26 Effects of interventions on measures of vegetable consumption or purchase reported in the included review articles by setting, population and/or strategy

Setting	Strategy tested	Population	Findings on vegetable intake or purchase	Reference [author, year]
Early childhood education and care	Healthy lifestyle promotion	Children (6mo-6y)	SMD = 0.12 [95% CI -0.01, 0.25]; p=0.08 *; n=13 studies *Equivalent to 0.14 servings of vegetables*	Yoong et al., 2023
	Healthy lifestyle promotion	Children (6mo-6y)	Low SES: SMD = −0.04 [95% CI −0.19, 0.11]; n=4 studies	Yoong et al., 2023
	Healthy lifestyle promotion	Children (6mo-6y)	High SES: SMD = 0.19 [95% CI 0.03, 0.35]; n=9 studies	Yoong et al., 2023
	Mix of strategies	Children (2-5y)	ES = 0.39 [95% CI 0.28, 0.50]; n=22 studies	Nekitsing et al., 2018
	Nutrition education	Children (6mo-6y)	Targeted the Curriculum: SMD = 0.07 [95% CI −0.01, 0.16]; n=9 studies	Yoong et al., 2023
	Nutrition education	Children (6mo-6y)	Did not target the Curriculum: SMD = 0.21 [95% CI −0.19, 0.60]; n=4 studies	Yoong et al., 2023
	Use of partnerships	Children (6mo-6y)	Targeted Partnerships: SMD = 0.11 [95% CI −0.04, 0.25]; n=11 studies	Yoong et al., 2023
	Use of partnerships	Children (6mo-6y)	Did not target Partnerships: SMD = 0.19 [95% CI −0.19, 0.57]; n=2 studies	Yoong et al., 2023
School	Healthy lifestyle promotion	Children (4-18y)	Comprehensive School Health approach: ES = 0.12 [95% CI −0.01, 0.25] servings/d or times/d; n=4 studies	Dabravolskaj et al., 2020
	Healthy lifestyle promotion	Children (4-18y)	Modifications of school nutrition policies: ES = −0.02 [95% CI −0.1, 0.06] servings/d or times/d; n=1 study	Dabravolskaj et al., 2020
	Healthy lifestyle promotion	School students aged 4-18y	20.82 g/d [95% CI 8.87, 32.78], t2=307.58 *; n=13 studies	Nury et al., 2022
	Mix of strategies	School-aged children ≤19y	0.01 [95% CI -0.00, 0.02]; n=13 studies	Pineda et al., 2021
	Nutrition education	Adolescents (10-19y)	MD = 0.59 [95% CI 0.15, 1.03] (times/wk) *; n=2 studies	deMedeiros et al., 2022
	Nutrition education	School students aged 4-18y	Multicomponent: MD = 12.32 [95% CI -11.03, 35.68] g/day; n=6 studies	Nury et al., 2022
	Nutrition education	School students aged 4-18y	Nutrition friendly school initiatives: MD = 12.80 [95% CI -34.68, 60.28] g/day; n=1 study	Nury et al., 2022

Setting	Strategy tested	Population	Findings on vegetable intake or purchase	Reference [author, year]
	Nutrition education	School students aged 4-18y	Nutrition education and literacy: MD = 31.46 [95% CI 9.49, 53.43] g/day; n=6 studies	Nury et al., 2022
	Nutrition education	School-aged children 4-12y	SMD = 0.25 units [95% CI 0.05, 0.45]; p<0.001); n=7 studies	Vaughan et al., 2024
	Provision	Children (2-18y)	Habitual vegetable intake, ES = 0.04 servings/d [95% CI 0.01, 0.08] ; n=11 studies	Micha et al., 2018
	Provision	Children (2-18y)	In-school total vegetable intake, ES = 0.03 servings/d (95% CI -0.06, 0.11]; n=3 studies	Micha et al., 2018
	Provision	Children (5-11y)	Habitual vegetable intake, primary school, ES = 0.05 servings/d [95% CI -0.01, 0.11] ; n=7 studies	Micha et al., 2018
	Provision	Children (12-18y)	Habitual vegetable intake, secondary school, ES = -0.06 servings/d [95% CI -0.39, 0.27] ; n=2 studies	Micha et al., 2018
	Provision	Children (2-18y)	Provision – free: Habitual vegetable intake, ES = 0.07 servings/d [95% CI 0.03, 0.11]; n=7 studies	Micha et al., 2018
	Provision	Children (2-18y)	Provision – reduced/full cost: Habitual vegetable intake, ES = -0.01 servings/d [95% CI -0.12, 0.09]; n=4 studies	Micha et al., 2018
	Provision	Children (2-18y)	Food policy only: Habitual vegetable intake, ES = -0.09 servings/d [95% CI -0.23, 0.06]; n=2 studies	Micha et al., 2018
	Provision	Children (2-18y)	Multi-component: Habitual vegetable intake, ES = 0.05 servings/d [95% CI 0.02, 0.09]; n=9 studies	Micha et al., 2018
	Provision	Children (2-18y)	School meal standards (alone or in combination with direct provision): Habitual vegetable intake, ES = 0.30 servings/d [95% CI -0.001, 0.59] ; n=2 studies	Micha et al., 2018
	Provision	Children (2-18y)	School meal standards (alone or in combination with direct provision): In-school total vegetable intake, ES = 0.003 [95% CI -0.11, 0.12]; n=4 studies	Micha et al., 2018
	Provision	Students (10-19y)	Vegetable serves consumed: MD = 0.06 [95% CI 0.01, 0.10]; p = 0.024; n=4 studies	Mingay et al., 2022
Community	Mix of strategies	Adults (≥18y)	WMD = 0.15 servings/d [95% CI 0.09, 0.21] *; n=9 studies	Jabbari et al., 2024
	Mix of strategies	Adults (≥18y)	ES = 0.24 [95% CI 0.13, 0.34]; n=5 studies	Jabbari et al., 2024

Setting	Strategy tested	Population	Findings on vegetable intake or purchase	Reference [author, year]
	Mix of strategies	Adults (≥18y)	Municipality: WMD = 0.11 servings/d [95% CI 0.05, 0.17]; n=1 study	Jabbari et al., 2024
	Mix of strategies	Adults (≥18y)	University: ES = 0.15 [95% CI 0.05, 0.24]; n=2 studies	Jabbari et al., 2024
	Modes of delivery	Adults (≥18y)	Face-to-face: ES = 0.15 [95% CI 0.06, 0.24]; n=6 studies	Jabbari et al., 2024
	Modes of delivery	Adults (≥18y)	Digital ES = 0.16 [95%CI 0.08, 0.24]; n=3 studies	Jabbari et al., 2024
	Nutrition education	Older adults (≥60y)	Seniors centres: ES = 0.24 [95% CI 0.09, 0.39]; n=2 studies	Neves et al., 2020
	Use of theory	Adults (≥18y)	Theory-based: ES = 0.15 [95% CI 0.09, 0.21]; n=4 studies	Jabbari et al., 2024
	Use of theory	Adults (≥18y)	Non-theory-based: ES = 0.13 [95% CI 0.02, 0.25]; n=5 studies	Jabbari et al., 2024
Home	Lunchbox intervention	Children (2-18y)	Provision of vegetables SMD = 0.40 [95% CI 0.16, 0.64]; p = 0.001; n=4 studies *Equivalent to a MD of 0.28 serves*	Nathan et al., 2019
	Lunchbox intervention	Children (2-18y)	Consumed in centre-based care: SMD = 0.26 [95% CI 0.08, 0.44], p = 0.005; n=2 studies *Equivalent to a MD of 0.18 serves*	Nathan et al., 2019
	Lunchbox intervention	Children (2-18y)	Consumed at school: SMD = 0.72 [95% CI -0.22, 1.66], p =0.13; n=2 studies	Nathan et al., 2019
	Mix of strategies	Children (2-12y)	% change in vegetable intake = 29% [range: -20% to +87%]; n=22 studies *Equivalent to ~ ¼ to ½ of a vegetable serving*	Hendrie et al., 2017
	Mix of strategies	Adults (≥18y)	ES = -0.03 [95% CI -0.20, 0.13]; n=1 study	Jabbari et al., 2024
	Mix of strategies	Children (2-5y)	ES = 0.51 [95% CI 0.26, 0.75]; n=6 studies	Nekitsing et al., 2018
	Modes of delivery	Young adults (18-35y)	Digital: ES = 0.15 servings/day [95% CI 0.04, 0.28]; n=5 studies	Nour et al., 2016
	Nutrition education	Older adults (≥60y)	Free-living: ES = 0.25 [95% CI 0.13, 0.37]; n=2 studies	Neves et al., 2020
	Nutrition education	Children (2-12y) and their parents	Hedges' g= 0.125; SE = 0.082 [95%CI -0.035, 0.285]; n=6 studies	Touyz et al., 2018
	Taste exposure	Children (2-12y) and their parents	Hedges' g=0.438; SE=0.064 [95%CI 0.312, 0.564]; n=6 studies	Touyz et al., 2018

Setting	Strategy tested	Population	Findings on vegetable intake or purchase	Reference [author, year]
Workplace	Healthy lifestyle promotion	Employed individuals	Multi-component workplace wellness programs: 0·03 servings/d [95% CI –0·04, 0·10]; n=12 studies	Peñalvo et al., 2021
Multiple settings	Mix of strategies	Children (2-5y)	ES = 0.30 [95% CI −0.07, 0.67]; n=2 studies	Nekitsing et al., 2018
	Mix of strategies	Children (2-5y)	ES = 0.36 [95% CI 0.22, 0.50]; n=10 studies	Nekitsing et al., 2018
	Mix of strategies	Children (2-5y)	g=0.40 [95% CI 0.31, 0.50]; Z=8.00, p < 0.001; n=30 studies	Nekitsing et al., 2018
	Modes of delivery	Adults (≥18y)	Face to face and eHealth blended: SMD = 0.59 [95% CI 0.27, 1.44], Z = 1.34; p = 0.18) *; n=3 studies	Yang et al., 2023
	Nudging	No restrictions	d = 0.10 [95% CI 0.001, 0.205]; n=6 studies	Broers et al., 2017
	Nutrition education	Children (2-5y)	ES = 0.26 [95% CI 0.13, 0.39]; n=10 studies	Nekitsing et al., 2018
	Nutrition education	Older adults (≥60y)	ES = 0.25 [95% CI 0.15, 0.34]; n=4 studies	Neves et al., 2020
	Nutrition education	Older adults (≥60y)	Group sessions: ES = 0.24 [95% CI 0.14, 0.34]; n=2 studies	Neves et al., 2020
	Nutrition education	Older adults (≥60y)	Individual sessions: ES = 0.39 [95% CI -0.02, 0.80]; n=2 studies	Neves et al., 2020
	Nutrition education	Older adults (≥60y)	Mediterranean diet: ES = 0.25 [95% CI 0.13, 0.37]; n=2 studies	Neves et al., 2020
	Nutrition education	Older adults (≥60y)	Fruit, legume, nuts: ES = 0.24 [95% CI 0.09, 0.39]; n=2 studies	Neves et al., 2020
	Taste exposure	Children (2-5y)	ES = 0.57 [95% CI 0.43, 0.70]; n=10 studies	Nekitsing et al., 2018
	Taste exposure	No restrictions	Repeated taste-based exposure, between subjects comparisons: SMD = 0.23 [95% CI 0.07, 0.39], p < 0.01 *; n=21 comparisons *Effect sizes equate to an increase in intake of ~10 g vegetables*	Appleton et al., 2018
	Taste exposure	No restrictions	Taste-based conditioning strategies v. Repeated taste-based exposure, between subjects comparisons: SMD = 0.12 [95% CI −0.08, 0.31], p = 0.23; n=38 comparisons *Effect sizes equate to an increase in intake of ~9 g vegetables*	Appleton et al., 2018
	Taste exposure	No restrictions	Repeated taste exposure or conditioning v. no exposure or repeated taste exposure, between subjects comparisons:	Appleton et al., 2018

Setting	Strategy tested	Population	Findings on vegetable intake or purchase	Reference [author, year]
			SMD = 0.32 [95% CI 0.10, 0.53], p < 0.01; n=24 comparisons *Effect sizes equate to an increase in intake of ~12 g vegetables.*	
	Use of theory	Children (2-18y)	Initiatives with behavioural theoretical foundation: g = 0.755 [95% CI, 0.450, 1.061], p < 0.05 *; n=16 studies	Diep et al., 2014
	Use of theory	Children (2-18y)	Theory-based: g=0.181; M = 0.181, SE = 0.078); n=9 studies *Meta-regression analyses revealed no association between the number of theories and vegetable consumption*	Diep et al., 2014
	Use of theory	Children (2-18y)	Non-theory-based: g=0.138; M 0.138, SE 0.052; n=5 studies	Diep et al., 2014
	Use of theory	Children (2-18y)	Initiatives with behavioural theoretical foundation, with formal planning process: M = 0.176, SE 0.052; n=3 studies	Diep et al., 2014
	Use of theory	Children (2-18y)	Initiatives with behavioural theoretical foundation, without formal planning process: M = 0.171, SE 0.064; n=11 studies	Diep et al., 2014

Abbreviations: CI, confidence interval; d, days; ES, effect size; g, grams; M, mean; MD, mean difference; NR = not reported; SES, socioeconomic status; SMD, standardised mean difference; WMD, weighted mean difference.

Note: *, compared to usual practice or no-intervention control group(s); grey shading indicates the results from the primary analysis of main (overall) findings, unshaded cells indicate results from sub-group analyses.

Appendix 1G

Reference Tables

Table 27 Characteristics of reviews included in the rapid overview of systematic reviews

Reference [author, year]	Aim of the review	Review eligibility criteria			Search period	Outcomes (units of measurement)*	Synthesis method ^
		Study designs included	Population and setting	Intervention strategy(ies) tested			
Appleton et al., 2018 (Appleton et al., 2018)	To identify and synthesize the current evidence for the use of repeated exposure and conditioning strategies for increasing vegetable liking and consumption	Between-group or within-group studies	No restrictions on population or setting	Repeated taste-based exposure; Taste-based conditioning strategies	Inception to Feb 2018	Vegetable consumption (NR)	Meta-analysis
Broers et al., 2017 (Broers et al., 2017)	To test the effects of nudging to encourage people to select more fruit and vegetables	Experimental or cross-sectional studies	No restrictions on population or setting	Nudging	Inception to Dec 2016	Vegetable choice (grams, servings); Vegetable sales (voucher sales, food sales)	Meta-analysis
Dabravolskaj et al., 2020 (Dabravolskaj et al., 2020)	To examine the effectiveness of school-based intervention types perceived by Canadian stakeholders in health and education as feasible, acceptable and sustainable in terms of improving physical activity (PA), fruit and vegetable intake, and body weight	Comparative studies	Children and adolescents (4-18y) School	Obesity prevention interventions	Jan 2012 to Jan 2020	Vegetable consumption (servings/d, times/d)	Meta-analysis
deMedeiros et al., 2022 (de Medeiros et al., 2022)	To evaluate the effects of school-based food and nutrition education interventions on adolescent food consumption	RCTs	Adolescents (10-19y) School	Education	Inception to Jun 2019	Vegetable consumption (times/wk)	Meta-analysis
Diep et al., 2014 (Diep et al., 2014)	To test the hypotheses that interventions clearly based on theory, multiple theories, or a formal intervention planning process will be more effective in changing fruit and vegetable	Comparative studies	Children and adolescents (2-18y) NR	Behaviour change techniques	1989 to 2013	Vegetable consumption (NR)	Meta-analysis

Reference [author, year]	Aim of the review	Review eligibility criteria			Search period	Outcomes (units of measurement)*	Synthesis method ^
		Study designs included	Population and setting	Intervention strategy(ies) tested			
	consumption among children than interventions with no behavioural theoretical foundation						
Hendrie et al., 2017 (Hendrie et al., 2017)	To identify intervention characteristics associated with increasing consumption of vegetables in children (2–12 years)	Prospective studies	Children (2-12y) Home and community settings	No restrictions	2004 to Jun 2014	Vegetable consumption (grams, servings, times/d); Vegetable provision (number of vegetables available or served); Vegetable purchasing (shopping receipts)	Quantitative (% change)
Jabbari et al., 2024 (Jabbari et al., 2024)	To systematically examine the effects of community-based interventions on fruits and vegetables consumption in adults	RCTs or non-RCTs	Adults (≥18y) Community	NR	Jan 2000 to Jul 2021	Vegetable consumption (servings/day)	Meta-analysis
Micha et al., 2018 (Micha et al., 2018)	To systematically review and quantify the impact of school food environment policies on dietary habits, adiposity, and metabolic risk in children	RCTs or quasi-experimental studies	Children and adolescents (2-18y) School	School food environment policies	Inception to Dec 2017	Vegetable consumption (reported intakes), or sales/purchase data as proxy for consumption)	Meta-analysis
Mingay et al., 2022 (Mingay et al., 2022)	To examine interventions in secondary schools that provide a routine meal service and the impact on adolescents' food behaviours, health and dining experience in this setting	RCTs, non-RCTs or single group pre-post studies	Adolescents (10-19y) School	Food provision	Inception to Dec 2021	Vegetable consumption (% of serve consumed of a meal component by students, mean number of serves consumed per student/d); Vegetable selection (% of students	Meta-analysis

Reference [author, year]	Aim of the review	Review eligibility criteria			Search period	Outcomes (units of measurement)*	Synthesis method ^
		Study designs included	Population and setting	Intervention strategy(ies) tested			
						selecting a meal component mean number of serves selected per student/d)	
Nathan et al., 2019 (Nathan et al., 2019)	To assess the effectiveness of lunchbox interventions aiming to improve the foods and beverages packed and consumed by children at centre-based care or school; and subsequent impact on children's adiposity	RCTs or non-RCTs	Children and adolescents (2-18y) Home	Lunchbox interventions	1995 to Jan 2017	Vegetable consumption or provision (serves, portions, or grams)	Meta-analysis
Nekitsing et al., 2018 (Nekitsing et al., 2018)	To identify the most successful strategies to enhance vegetable intake in preschool children aged 2–5 years	No restrictions	Children (2-5y) No restrictions	No restrictions	2005 to Jan 2016	Vegetable consumption (grams, observations, FFQ score)	Meta-analysis
Neves et al., 2020 (Neves et al., 2020)	To evaluate the efficacy of randomized clinical trials of nutritional interventions in food habits among older people	RCTs	Older adults (≥60y) NR	Educational interventions	Inception to Oct 2018	Vegetable consumption (NR)	Meta-analysis
Nour et al., 2016 (Nour et al., 2016)	To evaluate the efficacy and external validity of electronic (eHealth) and mobile phone (mHealth) -based interventions that promote vegetable intake in young adults	RCTs	Young adults (18-35y) NR	Digital - eHealth and mHealth interventions	1990 to Aug 2015	Vegetable consumption (servings, cups, frequency, or percentage consumption)	Meta-analysis
Nury et al., 2022 (Nury et al., 2022)	To examine the effects of different nutritional intervention strategies in the school setting on anthropometric and quality of diet outcomes by comparing and ranking outcomes in a network meta-analysis	Cluster RCTs	Children and adolescents 4-18y School	Nutritional interventions; no restrictions	Inception to May 2022	Vegetable consumption (grams, portions, cups, pieces or servings)	Meta-analysis

Reference [author, year]	Aim of the review	Review eligibility criteria			Search period	Outcomes (units of measurement)*	Synthesis method ^
		Study designs included	Population and setting	Intervention strategy(ies) tested			
Peñalvo et al., 2021 (Peñalvo et al., 2021)	To comprehensively study the effectiveness of multicomponent worksite wellness programmes for improving diet and cardiometabolic risk factors	RCTs or quasi-experimental studies	Employed individuals Workplace	Multi-component workplace wellness programs	Jan 1990 to Jun 2020	Vegetable consumption (servings/d)	Meta-analysis
Pineda et al., 2021 (Pineda et al., 2021)	To assess the effectiveness of interventions on the food environment within and around schools to improve dietary intake and prevent childhood obesity	NR	School-aged children and adolescents (≤19y) School	Obesity prevention or healthy eating interventions	Inception to Jan 2020	Vegetable consumption (NR); Vegetable purchasing (NR)	Meta-analysis
Touyz et al., 2018 (Touyz et al., 2018)	To examine the effectiveness of parent-targeted in-home interventions in increasing fruit and vegetable intake in children	RCTs, non-RCTs or pre-post studies	Children (2-12y) and their parents Home	Parent-targeted; no restrictions	Jan 2000 to Aug 2016	Vegetable consumption (grams or servings/d)	Meta-analysis
Vaughan et al., 2024 (Vaughan et al., 2024)	To investigate the impact of school-based cooking classes on cooking skills, food literacy and vegetable intake of children aged 4–12 years	RCTs, cluster RCTs or quasi-experimental studies	Children (4-12y) School	Practical nutrition education classes	Jan 2001 to Dec 2021	Vegetable consumption (servings/d, intake score, number of days vegetables consumed at supper)	Meta-analysis
Yang et al., 2023 (Yang et al., 2023)	To synthesize the characteristics of blended interventions and meta-analyse the effectiveness of blended interventions in promoting PA, diet, and weight-related outcomes among adults	RCTs or cluster RCTs	Adults (≥18y) NR	Face-to-face and eHealth blended interventions	Jan 2002 to Jul 2022	Vegetable consumption (NR)	Meta-analysis
Yoong et al., 2023 (Yoong et al., 2023)	To assess the effectiveness of healthy eating interventions delivered in ELEC settings for improving dietary intake in children aged six months to six years, relative to usual care, no	RCTs including cluster RCTs, stepped-wedge RCTs, factorial RCTs, multiple baseline RCTs,	Children (6mo-6y) Early childhood education and care settings	Healthy eating interventions	Inception to Feb 2022	Vegetable consumption (servings, portions, times, weight)	Meta-analysis

Reference [author, year]	Aim of the review	Review eligibility criteria			Search period	Outcomes (units of measurement)*	Synthesis method ^
		Study designs included	Population and setting	Intervention strategy(ies) tested			
	intervention or an alternative, non-dietary intervention	and randomised crossover trials					

Note: *, only outcomes relevant to the aim of this rapid review were extracted, that is vegetable intake or purchase; ^, where the synthesis method differed between outcomes, the synthesis method for the analysis of vegetables was extracted.

Abbreviations: d, day; FFQ, food frequency questionnaire; mo, months; NR, not reported; RCT, randomised controlled trial; wk, week; y, years.

Table 28 Narrative synthesis of the main effects of interventions on measures of vegetable consumption or purchase reported in the included systematic review articles, by setting

Reference [author, year]	Total no. of primary articles (no. reporting on vegetables)	Setting	Overall findings*	Risk of bias
Yoong et al., 2023	52 (17)	Early childhood education and care settings	**Early childhood education and care-based healthy eating interventions increased vegetable consumption compared with usual practice/control group**	Low
Dabravolskaj et al., 2020	83 (14)	School	No obesity prevention interventions showed a statistically significant effect on vegetable consumption	Low
deMedeiros et al., 2022	24 (9)	School	**Food and nutrition education interventions in schools led to a positive and significant effect on the consumption of vegetables for the intervention group**	Low
Micha et al., 2018	91 (11)	School	No pooled analysis was undertaken; findings were separated by intervention type and setting	Low
Mingay et al., 2022	39 (18)	School	**Modifying food service practices improved students' consumption and selection of vegetables**	Low
Pineda et al., 2021	100 (13)	School	Interventions on the food environment that focus on obesity prevention and healthy eating showed no significant change in vegetable consumption	High
Nury et al., 2022	51 (13)	School	**Nutritional interventions showed a moderate increase in vegetable consumption compared with a control group**	Low
Vaughan et al., 2024	21 (7)	School	**Practical nutrition education classes showed a small, but significant effect on vegetable consumption**	High
Jabbari et al., 2024	21 (9)	Community	**Community-based interventions (regardless of their types) significantly increased vegetable consumption compared to the control groups**	Low
Hendrie et al., 2017	22 (22)	Home and community	Interventions that targeted children's vegetable consumption in the home or community settings were generally effective #	Low
Nathan et al., 2019	10 (5)	Home	**Lunchbox interventions led to a moderate increase in provision of vegetables**	Low
Touyz et al., 2018	20 (12)	Home	No pooled analysis was undertaken; findings were separated by intervention type	High
Peñalvo et al., 2021	121 (20)	Workplace	Multi-component workplace wellness programs showed no significant benefit for vegetable consumption	Low
Appleton et al., 2018	43 (43)	No restrictions	No pooled analysis was undertaken; findings were separated by intervention type	Low
Broers et al., 2017	20 (6)	No restrictions	**Nudging interventions produced a small but significant effect on vegetable choice**	High

Diep et al., 2014	29 (16)	Not reported	**Interventions that employed behaviour change procedures had a large and significantly greater impact on vegetable consumption than control conditions**	Low
Nekitsing et al., 2018	30 (30)	No restrictions	**Strategies to increase vegetable consumption in preschool children had a small-moderate significant effect on vegetable consumption, compared with control group**	High
Neves et al., 2020	11 (4)	Not reported	**Nutritional education programs were effective in increasing vegetable consumption in older adults**	High
Nour et al., 2016	14 (6)	Not reported	Digital interventions showed a negligible effect on changing vegetable consumption	Low
Yang et al., 2023	17 (5)	Not reported	Face-to-face and eHealth blended interventions did not significantly increase vegetable consumption compared with the control group	Low

Note: *bold text indicates significant effect on vegetable intake; #, indicates statistical significance was not tested.

7.2 Appendix – Module 2

Appendix 2A

Standardised list of vegetable categories included in baseline modelling

Vegetable category
Asian Vegetables
Avocados
Beans
Beetroot
Broccoli Broccolini
Cabbage
Capsicum
Carrots
Cauliflower
Celery
Chickpeas
Corn
Cucumbers
Fresh Salad
Garlic
Herbs
Lettuce
Mushrooms
Onions
Other Vegetable
Peas
Potatoes
Prepared Vegetable
Pumpkin
Sweet potatoes/Kumara
Tomatoes
Zucchini/Courgette

Appendix 2B

List of vegetable categories included in baseline modelling for NIQ data

Vegetable Category	NIQ Categories
Asian Vegetables	Asian Vegetables
Avocados	Hass Avocados
Avocados	Shepard Avocados
Avocados	Other Avocados
Beans	Beans
Beetroot	Beetroot
Broccoli Broccolini	Broccoli
Broccoli Broccolini	Broccolini
Cabbage	Cabbage
Capsicum	Capsicum
Carrots	Carrots
Cauliflower	Cauliflower
Celery	Celery
Cucumbers	Cucumbers
Fresh Salad	Fresh Salad
Garlic	Garlic
Herbs	Herbs
Lettuce	Lettuce
Mushrooms	Swiss Browns Mushrooms
Mushrooms	Whites Mushrooms
Mushrooms	Other Mushrooms
Onions	Brown Onions
Onions	Red Onions
Onions	White Onions
Onions	Other Onions
Other Vegetable	Eggplant
Other Vegetable	Kale
Other Vegetable	Leek
Other Vegetable	Silverbeet/Spinach
Other Vegetable	All other Vegetables
Potatoes	Potatoes
Prepared Vegetable	Prepared Vegetable
Pumpkin	Butternut Pumpkin
Pumpkin	Kent Pumpkin
Pumpkin	Other Pumpkin
Snow/Snap Peas	Snow/Snap Peas
Sweet Corn	Sweet Corn
Sweet potatoes/Kumara	Sweet potatoes/Kumara
Tomatoes	Cherry Tomatoes
Tomatoes	Grape Tomatoes
Tomatoes	Roma Tomatoes
Tomatoes	Standard Tomatoes
Tomatoes	Tomatoes No Stem
Tomatoes	Truss Tomatoes

Tomatoes	Other Tomatoes
Zucchini/Courgette	Zucchini/Courgette

Appendix 2C

List of vegetable categories included in baseline modelling for Simplot data

Vegetable Category	Simplot Categories
Beans	Vegetables Single Basic Green Beans
Beans	Vegetables Single Basic Broad Beans
Beans	Green Beans
Beans	Adzuki Beans
Beans	Bean Mix
Beans	Black Beans
Beans	Borlotti Beans
Beans	Butter/Lima Beans
Beans	Cannellini Beans
Beans	Edamame/Soya
Beans	Fava/Broad Beans
Beans	Kidney Beans
Beans	Lentils
Beans	Lupini Beans
Beans	Mexican/Chilli Beans
Beans	Mung Beans
Beans	Other Wet Seed Beans
Beans	Pinto Beans
Beans	Wet Seed Beans Salads
Beetroot	Beetroot
Broccoli Broccolini	Vegetables Single Basic Broccoli
Cabbage	Sauerkraut/Cabbage
Capsicum	Vegetables Single Basic Capsicum
Capsicum	Capsicums
Carrots	Vegetables Single Basic Carrots
Carrots	Carrots
Cauliflower	Vegetables Single Basic Cauliflower
Chickpeas	Chickpeas
Corn	Vegetables Single Basic Corn
Corn	Vegetables Snacking Basic Corn
Corn	Vegetables Snacking Basic Corn Kernels
Corn	Vegetables Single Flavoured Corn
Corn	Corn Kernels
Corn	Creamed Corn
Corn	Baby Corn Spears
Cucumbers	Cucumber
Herbs	Vegetables Herbs
Mushrooms	Vegetables Single Basic Mushrooms
Mushrooms	Mushrooms
Onions	Vegetables Single Basic Onion

Other Vegetable	Vegetables Mixed Basic Versatile
Other Vegetable	Vegetables Steamed Basic
Other Vegetable	Vegetables Mixed Basic Stir Fry
Other Vegetable	Vegetables Single Basic Spinach
Other Vegetable	Vegetables Steamed Flavoured
Other Vegetable	Vegetables Carb Alternatives
Other Vegetable	Vegetables Single Basic Brussel Sprouts
Other Vegetable	Vegetables Single Basic Edamame
Other Vegetable	Vegetables Mixed Flavoured
Other Vegetable	Vegetables Bakes
Other Vegetable	Vegetables Single Basic Kale
Other Vegetable	Vegetables Premium
Other Vegetable	Vegetables Mixed Basic Roast
Other Vegetable	Artichokes
Other Vegetable	Asparagus
Other Vegetable	Dehydrated Veg
Other Vegetable	Eggplant
Other Vegetable	Hearts Of Palm
Other Vegetable	Mixed Veg
Other Vegetable	Other Vegetables
Other Vegetable	Okra
Other Vegetable	Other Veg Salads
Other Vegetable	Stir Fry Veg
Other Vegetable	Turnip
Other Vegetable	Vine Leaves
Peas	Vegetables Single Basic Peas
Peas	Peas
Pumpkin	Vegetables Single Basic Pumpkin
Sweet potatoes/Kumara	Vegetables Single Basic Sweet Potato
Zucchini/Courgette	Vegetables Single Basic Zucchini

Appendix 2D

List of vegetable categories included in baseline modelling for EFW data

Vegetable Category	**EFW Categories**
Artichoke	Other Vegetable
Asparagus	Other Vegetable
Asparagus stem/end	Other Vegetable
Avocado	Avocados
Avocado pip/seed	Avocados
Bamboo	Asian Vegetables
Basil	Herbs
Bay leaves	Herbs
Bean	Beans
Bean (green) ends	Beans
Beetroot	Beetroot
Beetroot leaves	Beetroot

Black bean	Beans
Bok Choy / pak choi	Asian Vegetables
Bok Choy / pak choi ends	Asian Vegetables
Broad bean	Beans
Broad bean husks	Beans
Broccoli	Broccoli Broccolini
Broccoli stem/ leaves	Broccoli Broccolini
Broccolini	Broccoli Broccolini
Brussel sprout ends	Other Vegetable
Brussel sprouts	Other Vegetable
Cabbage	Cabbage
Cabbage stem/outer leaves	Cabbage
Capers	Other Vegetable
Capsicum	Capsicum
Capsicum seeds/ core	Capsicum
Cardamom	Other Vegetable
Carrot	Carrots
Carrot peel	Cabbage
Carrot top/stems	Carrots
Cassava	Other Vegetable
Cassava end	Other Vegetable
Cauliflower	Cauliflower
Cauliflower stem/leaves	Cauliflower
Celeriac	Other Vegetable
Celeriac end/leaves	Other Vegetable
Celery	Celery
Celery end	Celery
Chickpea	Chickpeas
Chicory	Other Vegetable
Chilli	Other Vegetable
Chinese broccoli	Asian Vegetables
Chives	Herbs
Choko	Other Vegetable
Choy sum	Asian Vegetables
Choy sum ends	Asian Vegetables
Chutney	Prepared Vegetable
Coriander stems	Herbs
Coriander/cilantro	Herbs
Coriander/cilantro seed	Herbs
Corn	Corn
Corn cob	Corn
Cucumber	Cucumbers
Cucumber end	Cucumbers
Curry	Herbs
Curry leaves	Herbs
Dill	Herbs
Edamame	Beans

Eggplant/aubergine	Other Vegetable
Endive	Other Vegetable
Fennel	Other Vegetable
Fennel end/core	Other Vegetable
Fenugreek	Other Vegetable
Garlic	Garlic
Garlic peel	Garlic
Gherkin	Other Vegetable
Ginger	Other Vegetable
Ginger peel	Other Vegetable
Grape vine leaf	Other Vegetable
Grape vine leaf	Other Vegetable
Kale	Other Vegetable
Kale stem/end	Other Vegetable
Kidney bean	Beans
Kohlrabi	Other Vegetable
Leek	Other Vegetable
Leek end	Other Vegetable
Lemongrass	Other Vegetable
Lentil	Other Vegetable
Lettuce	Lettuce
Lettuce end/stem	Lettuce
Lupin	Beans
Mint	Herbs
Mixed salad leaves	Fresh Salad
Mushroom	Mushrooms
Mustard seeds	Other Vegetable
Okra	Other Vegetable
Olive	Other Vegetable
Onion	Onions
Onion peel	Onions
Oregano	Herbs
Other vegetable cores/seeds/stems/stalks	Other Vegetable
Other vegetable peel/skin (edible)	Other Vegetable
Other vegetable peel/skin (inedible)	Other Vegetable
Parsley	Herbs
Parsley stems	Herbs
Parsnip	Other Vegetable
Peas	Peas
Peas/bean pod	Beans
Peppers	Capsicum
Potato	Potatoes
Potato peel	Potatoes
Pulse (raw, cooked, preserved, dried)	Other Vegetable
Pumpkin	Pumpkin
Pumpkin peel	Pumpkin
Pumpkin seeds/stem (raw, from pumpkin)	Pumpkin

Radicchio	Other Vegetable
Radicchio stem	Other Vegetable
Radish	Other Vegetable
Rocket/arugula	Lettuce
Rocket/arugula /arugula	Lettuce
Rosemary	Herbs
Sage	Herbs
Salad	Fresh Salad
Shallot	Onions
Silverbeet	Other Vegetable
Snow pea	Peas
Snow peas	Peas
Soy sausages/ soy bacon/ soy mince	Other Vegetable
Spinach (english)	Other Vegetable
Spring onion/scallions/ shallot / french onion ends/tops	Onions
Sprouts	Other Vegetable
Squash	Other Vegetable
Swede	Other Vegetable
Sweet potato	Sweet potatoes/Kumara
Taro	Other Vegetable
Thyme	Herbs
Tofu	Other Vegetable
Tomato	Tomatoes
Tomato vine (truss)	Tomatoes
Turmeric	Herbs
Vegetable (canned, frozen, cooked, dried)	Other Vegetable
Vegetable (raw)	Other Vegetable
Watercress	Other Vegetable
Yam	Other Vegetable
Zucchini/courgette	Zucchini/Courgette
Zucchini/courgette end/stem	Zucchini/Courgette

Appendix 2E

Out-of-home Settings Plans

Building a comprehensive baseline of vegetable consumption in Australia will require a multi-faceted approach with strategic collaboration across settings and sectors. Our assessment of each of the out-of-home settings highlights the challenges of working with fragmented data sources, a common lack of accurate data on vegetable-specific intake and difficulties addressing ethical considerations/requirements, (especially in education).

To overcome data limitations and be able to derive accurate insight into vegetable consumption out of home, we must move beyond traditional methods, leverage technology and innovation and embrace a mix of direct observation, food diaries (both physical and online), menu analysis (leveraging both manual review and AI), procurement records, waste audits, and targeted surveys or focus groups. A unified effort involving education institutions, food service providers, industry bodies, health professionals, government agencies, and food relief and aged care organizations will be key for success in design and implementation of these methods.

Next Steps and Recommendations for Out-of-Home Vegetable Consumption

A phased approach is recommended for implementing vegetable consumption interventions across various out-of-home settings. This approach is based on the current availability of data, partner engagement/collaboration, the potential for scalable impact to increase vegetable consumption as well as the desire for interventions within each setting.

Horizon 1: Prioritised Settings

Education settings (specifically primary, secondary, and tertiary settings), along with aged care facilities have been identified as high-priority targets for the initial phase (Horizon 1). These settings have demonstrated strong data availability and a recognised need for intervention. Aged care facilities, with their innovative data capture practices and focus on design-based solutions, can serve as exemplary models. Learnings from these settings can be effectively transferred and adapted for educational environments (where conversations are already being had to do so). Technology-driven interventions, such as AI-powered data capture tools, can be leveraged across both sectors.

Prioritising education settings is particularly impactful due to the potential for children and adolescents to influence both their families and future consumption behaviours in other settings.

Horizon 2: Intermediate Complexity Settings

Early learning, food service institutions, and retail settings are proposed to land in the second phase (Horizon 2) for ongoing work. These settings present slightly greater complexity and potentially lower initial priority. However, they often have engaged and willing partners, despite limited data so could be brought into the earlier horizon if in detailed scoping it appears worthwhile. Utilizing the insights, learnings, and methodologies from Horizon 1 will streamline the data gathering and analysis processes and accelerate progress to begin interventions in these settings.

Horizon 3: Fragmented and Unpartnered Settings

The remaining settings can be characterised by being fragmented, having a lack of existing data and absence of established partners. These are designated for the final phase (Horizon 3) and may include workplaces, food relief and other miscellaneous settings. Interventions in these areas will be explored once there is clarity on pathways or other insights emerge from the successful implementation of Horizons 1 and 2.

Technology Considerations

A range of innovative technologies, including artificial intelligence (AI) and machine learning tools, can be deployed across multiple settings to facilitate data capture, analysis, and personalized intervention strategies. Specific technology recommendations will be tailored to the unique needs of each sector and outlined in their respective implementation plans.

Initial discussions have shed light on interesting AI solutions. For example, a potential opportunity exists to leverage the use of a tool that captures consumption data through photographs or plated food pre and post consumption that is weighed and analysed (to see what it is), using machine learning to identify the foods on the plate (including vegetables).

This provider has worked with a large Australian aged care provider, in education settings and in other circumstances internationally. At the time of writing of this report, these datasets (for the aged care and education settings) were not viewed but if they are made accessible and meet the required quality standards, it may be advisable to establish a baseline analysis from here and leverage in horizon one.

Appendix 2E1

Early Learning

Places where young children receive educational and care services before entering formal schooling. For example, preschools, daycares, ELCs, family-run daycare). Demographic typically incl. children under 5 years old.

Key statistics and background on setting:	• Attendance rates are high for children in Early Learning. In 2022, 48.3% of all 0-5-year-olds utilised approved care services. Preschool enrolment reached 334,440, primarily for 4-year-olds. • There are over 14,000 approved operating services; including: - Centre Based Day Care: 62.8% (9,127 services) - Outside School Hours Care: 34.3% (4,987 services) • Preschool enrolment shows greater representation from advantaged areas, raising potential disparity concerns for vegetable consumption. • Children attend formal early learning settings, such as long day care, for significant periods (26.6 hours/week on average). This creates a substantial opportunity to influence food habits. • Food provision models vary greatly in the early learning setting: o Large corporate providers may have in-house food preparation. o Smaller centres might utilise external catering. o Parent-provided meals/snacks remain a significant factor.
What should be considered as a representative sample and who are major providers of service/ support in area?	In establishing a comprehensive baseline for vegetable consumption a representative sample should encompass various early learning types (centre-based, family day care and other outside of school care facilities), across various locations (urban, regional, remote), and socioeconomic backgrounds as well as the size of the centres. Major providers in Early Learning of interest (who we will require collaboration from) include: • Goodstart Early Learning; Australia's largest provider of early learning and care with over 700 centres across the country • G8 Education (owns and operates over 300 early learning centres across Australia) • Kids Academy (over 130 long day care centres located throughout Australia) • Guardian Childcare (~110 childcare centres across Australia) • Childhood nutrition researchers with expertise in dietary assessment methodologies (I.e. Edith Cowan University, Deakin University) • Parents Voice, Raising Children Network
Considerations in designing data framework /model for a baseline:	In Early Learning there are limited methodologies to capture dietary data. Methods involving data collection from children and/or centres will require additional time for approval via relevant ethics committees in the Department of Education and a robust data management to ensure ethical data handling and analysis. Robust data capture framework will likely need a combination of surveys with the centres or parents across various socioeconomic, geographic, and early learning setting types. Where possible, consider using technology to automate the data capture and collection (to minimize onus required on parents, teachers and staff). Utilising tools like the Compass group's food waste mapping tool and adapting this for early learning setting providers may be an option, alongside a form of image recognition software (for various lunch boxes and provided food).
Factors influencing vegetable consumption in this setting:	• Menu planning practices (with variations between on-site and packed meals) • Availability and presentation of vegetables • Parental influence on packed lunches, and the knowledge and attitudes of early learning staff towards nutrition.
Potential partners for working group:	• ECU • Deakin University • Nutrition Australia • Child Care Alliance • Healthy-Kids • Asiqua • AerVision

Appendix 2E2

Primary & OSCH

Encompasses the setting where primary school students attend classes during regular school hours and participate in organised care programs outside of school hours, such as before and after-school care. Demographic typically incl. children between 5 and 13 years old.

Key statistics and background on setting:	Population Characteristics: • In 2022 there were 2.25million students enrolled in 9,164 Australian schools; split between government, Catholic, and independent school systems. • 0.5% of the total school population are homeschooled. • Approximately 500,000 children utilise OSCH services. • A significant portion of primary school children (approximately 500,000 utilise OSCH services). Time Spent in Setting: • Primary school is full-time during regular school hours. • OSCH typically operates for several hours after school (3-6:30 pm). Food Provision Characteristics: • Home-packed lunches, school canteens, and snacks in OSCH. Canteen offerings are guided by state-based healthy canteen policies, but adherence varies.
What should be considered as a representative sample and who are major providers of service/ support in area?	A diverse sample of schools is needed; including government, Catholic, independent schools, schools with varying canteen services across socioeconomic areas and geographical locations. Sample size determination to be guided by statistical considerations, variability in vegetable intake, and feasibility of data collection. Major providers in the Primary School & OSCH setting to work with will include: • Local health promotion programs and public health nutritionists – (specific programs like "Crunch and Sip" have conducted evaluations and research) • School administrators and education departments. • Technology teams or companies specializing in AI for food imaging. • Canteen Managers/Providers and associations (FOCIS) • Nutrition Australia • OSCH providers (i.e. Camp Australia)
Considerations in designing data framework /model for a baseline:	Many methodologies exist to capture dietary data. Most used are student dietary surveys, lunchbox audit, canteen surveys, or parent surveys. Similarly to other Education settings - methods involving data collection from children and/or centres will require additional time for approval via relevant ethics committees in the Department of Education and a robust data management plan will be crucial for ethical data handling and analysis. Leveraging existing partner groups or programs of work may accelerate progress here. A robust data capture framework will likely need a combination of canteen procurement data (supply), lunchbox audit (home brought) and bin audit (food waste) across various socioeconomic, geographic, and early learning setting types. Where possible, consider using technology to automate the data capture and collection (to minimize onus required on parents, teachers, and staff). Utilising tools like the Compass group's food waste mapping tool or a form of image recognition software (for lunch boxes). Collaboration between schools, researchers, public health professionals, and potentially technology partners is crucial.
Factors influencing vegetable consumption in this setting:	• Canteen policies, offerings, availability, variety, pricing, and promotion of vegetables there. • Food literacy and nutrition education – I.e. curriculum encouraging/building knowledge about vegetables and healthy eating as well as parent influences and food literacy / nutrition education. • Nutritional quality of food packed from home in lunches boxes. • The types of snacks offered in OSCH settings.
Potential partners for working group:	• CSIRO • Deakin University • Newcastle University • Healthy-kids Association • Health and Wellbeing Queensland • Schools Buyers Guide • WA Policy • Parents Voice • ECU • AerVision • Child Care Alliance

Appendix 2E3

Secondary & Tertiary

Encompasses secondary schools where teenagers receive formal education. The tertiary setting includes colleges and universities where students pursue higher education after secondary school. Demographic typically incl. children between 13 and 17 years old then then adults 18+.

Key statistics and background on setting:	Population Characteristics: • 1.8m million students enrolled in approximately 1,400 Australian secondary schools (in 2022), with a breakdown across government, Catholic, and independent sectors. • Approximately 3.6 million students were enrolled in tertiary education nationwide (in 2022), split between Higher Education and VET sectors. • Different sources suggest a range between 20,000 to 30,000+ boarding students in Australia in approximately 250 boarding schools. • 42 universities in Australia which are a mix of public (37) and private (3), private international universities (2). Time Spent in Setting: • Secondary students typically attend full-time during school hours. • Tertiary students have variable schedules, affecting their on-campus presence – time in class, on-site tutorials and ability to engage in studies (i.e. lectures) remotely now too. Food Provision Characteristics • In secondary school students often rely on home prepared lunches, but the availability and offerings of school canteens or other external food providers are also frequently utilised. If a boarding school, students are accommodated with all meals typically five or seven days a week. • Tertiary students demonstrate greater autonomy in their food choices. Food brought from home remains a common practice, other options typically include on-campus canteens, food outlets and other external vendors.
What should be considered as a representative sample and who are major providers of service/ support in area?	Similarly to the primary and OSCH setting, a diverse sample of schools is needed including public, private, and faith-based schools, and schools with varying canteen services. There is significant variability in school types, sizes, socioeconomic areas and geographical locations, so this too should be factored into sample size. Representation from schools with on-site boarding houses / dormitories that have full catering kitchens should also be considered. In tertiary there is great variation in universities, TAFE institutes, and various VET providers, so a wide sample will be required to ensure coverage and build of a representative sample. Partnerships with universities or dedicated research organisations will be ideal for establishing a robust data management framework, such as: • School Administrators, Canteen Staff/programmes and Boarding House kitchens • Public Health Nutritionists (specifically involved in localised health promotion initiatives) • E.g. Localised health promotion initiatives (e.g. SAKG) • Researchers specializing in adolescent nutrition • CSIRO • University/TAFE Leadership and Catering Services • Researchers specializing in young adult nutrition • Government agencies responsible for education and health • Relevant NGOs or foundations (e.g. Jamie Oliver Foundation)
Considerations in designing data framework /model for a baseline:	A combination of methods for capturing data could be utilised such as lunchbox audits, online food diaries, rubbish bin audits and canteen sales data. A well-designed stratified sampling methodology is a must for both settings, factoring in the variables mentioned above. Management of the data capture (and collaboration on this) is key, potentially including schools, tertiary institutions, researchers, public health professionals, food service providers. To capture consumption data; proposed most efficient and effective ways will be through lunch box audits/diaries, canteen and hostel records (where available), bin audits, targeted surveys, and utilizing technology solutions too. Tools such as End Food Waste Australia, the 'Compass Food Waste Mapping Tool' and AI tools that utilise photographs of plated food pre and post consumption (that is weighed and analysed using machine learning to identify the vegetable consumption), will provide avenues for capturing and measuring food waste within educational environments. Integrating these tools into the research design could provide valuable insights into consumption patterns and potential areas for improvement. The recommended proposed plan would be to split this setting to two individual settings (Secondary and then separately tertiary) and work with a sample of the major providers who are best suited to each. In development, there is the need to understand where gaps and equally, where priorities are, (I.e. serving healthy meals (incorporating vegetables) vs calorie dense foods?)
Factors influencing vegetable consumption in this setting:	• Access to fresh produce and food preparation skills may vary depending on household income. • Availability and affordability of healthy options within school canteens. • Student preferences and established eating habits play a significant role, particularly in tertiary settings where students have greater autonomy. • Proximity to healthy food outlets can influence choices made outside the educational setting itself.
Potential partners for working group:	• Food Bank • Newcastle and Deakin University • Healthy-Kids Association • Schools Buyers Guide • Nutrition Australia • AerVision

Appendix 2E4

Workplaces

Any or all of the places where individuals perform assign work tasks by an employer - this includes an office, factory, construction site, workshop or home office.

Key statistics and background on setting:	• Australian workforce size: 14.2 million, with 9.8 million in full-time employment (February 2024) • Increasing percentage working from home (approximately 37% regularly), with variations across industries. • Typically meals would include home-packed lunches, commuting meals and on-site provided meals dining facilities. Proportion of workplace type that provides food: 7% of Accommodation and Food Services 15% of Health Care and Social Assistance 7% of Health Care (> 1,000,000 people in 2022)] 17% of public sector employees (2,430,400 people in 2023)
What should be considered as a representative sample and who are major providers of service/ support in area?	A representative model for workplaces should encompass multiple types of industries that vary in terms of remote working arrangements, various workplace sizes, work meal provision practices, etc. to ensure comprehensive representation. It should also consider availability of data on vegetable consumption within workplaces, both from internal corporate sources and external commercial entities. This model will largely overlap with consumption in other settings (particularly Home, Foodservice Institutional and Foodservice commercial), so understanding the overlap and influences will be key. Major providers of service/ support for data and model design will include: • Workplace representatives (HR, Occupational Health & Safety, Wellness Coordinators) • Large corporations, (especially those with on-site food services – i.e. Google or factories) • Foodservice providers (e.g. Compass, Sodexo or large catering companies) • Researchers specialising in workplace health and nutrition • Government agencies responsible for workplace health and public health nutrition
Considerations in designing data framework /model for a baseline:	There is potential to implement several methods for data collection. These include food diaries, app-based tracking, workplace surveys, procurement records from canteens (where available), and bin audits for waste. Each method has its advantages and limitations. Food diaries and app-based tracking provide granular data but rely heavily on employee participation and self-reporting, which can introduce bias. Workplace surveys offer a broader snapshot, while procurement records and bin audits focus on aggregate consumption and waste patterns. Key building blocks for a robust data framework in workplace settings should capture: • Individual-level data: Demographics (age, gender, job role), baseline dietary habits, and perceived barriers/motivators to vegetable consumption. • Food environment: Types of vegetables available in canteens/vending machines, pricing, promotional strategies, and healthy eating policies. • Temporal patterns: Consumption trends across weekdays/weekends/working-from-home and mealtimes (breakfast, lunch, snacks). Challenges will include participant engagement (including sustaining employee interest in data collection, particularly over longer periods), and data collection and integration – particularly on incorporating such large variations of work place environments. Ensuring partnerships and collaboration with large corporations, food service providers, and health tech companies who may possess existing data infrastructure will be key.
Factors influencing vegetable consumption in this setting:	• Variety, pricing, trends and convenience of options within or near workplaces • Culture of workplace (and encouragement, support from leadership and peers around healthy eating) • Work schedules and time pressure (whether time constraints and ability to source healthy food options are actual or perceived) • Individual preferences around healthy eating while at work
Potential partners for working group:	• Compass • Bidfood Australia (or other large wholesale foodservice group) • ECU • AerVision

Appendix 2E5

Foodservice Institutional

A business or other entity that provides food and beverages to a specific group of individuals for consumption outside of the home. For example, a hospital dining service, defence catering, mining, airline catering.

Key statistics and background on setting:	Foodservice institutional settings encompass a wide range of businesses and organisations that provide food and beverages to specific groups of people in a non-commercial setting. These settings typically involve captive audiences who consume meals prepared on-site or delivered by external caterers. Key examples include healthcare (hospitals and assisted living facilities), correctional facilities, military bases or government offices, travel institutions (airlines, trains and cruise ships) and remote sites i.e. mining camps and oil rigs). These settings share common characteristics, including: • Often large-scale operations serving many people on a regular basis. • Menu constraints (through budget restrictions, dietary requirements, or logistical challenges). • Health and safety regulations required to be adhered to protect the health of their patrons. • Focus on nutrition – with many institutions prioritising the ability to provide nutritious meals to support the health and well-being of their clientele. • Highly centralised meal provision with varying levels of individual choice (some institutions very limited choice, others major dietary requirements must be adhered to). Target consumers include patients/residents, staff, visitors, guests, inmates, travellers, soldiers and other military personal. Typically, three main meals daily provided with additional snacks with great variation based on reason for engagement or use of the institution (i.e. medical need (healthcare), inmate status, and military activities).
What should be considered as a representative sample and who are major providers of service / support in area?	A representative sample should encompass a diverse range of institutions to capture the variety. Including a representative sample across the following: • Healthcare by hospital type (public/private) and size and specialty • Correctional by facility type, security level • Government and travel, considering the unique demands and consumer types of the likes of military bases and government offices and various travellers and types of meals consumed within. Major providers of service/ support for data and model design will include: • Large food procurement companies (I.e. Compass or Bidfood) and software providers specialising in institutional foodservice • Major hospital chains (public and private), and hospital foodservice managers, dietitians • Correctional facilities foodservice managers • Defence force food procurement and nutrition personnel • Industry Associations and researchers specialising institutional food systems / food and nutrition within specific settings (healthcare, correctional) • Relevant regulatory bodies and Government agencies
Considerations in designing data framework /model for a baseline:	A robust data framework for vegetable consumption in foodservice institutional settings necessitates a multi-pronged approach. Centralised settings offer valuable insights through procurement records, menu analysis, meal audits (direct observation of plate waste or consumption), and waste audits. Individual-based data in select healthcare settings could be captured with food diaries, with potential consideration for tech-based solutions (i.e. image-based food diaries) to enhance accuracy and ease of participation. Key building blocks for comprehensive data capture in this setting include: • Institutional characteristics including facility type (hospital, aged care, prison, etc.) and foodservice model (self-operated vs. contracted) • Consumption patterns; i.e. meal audits provide real-time snapshots, while procurement and waste data offer broader trends across time (daily, weekly, seasonally). • Individual factors (where applicable) such as dietary restrictions, food preferences, and patient/resident demographics (if collected in a private manner) There is the potential to utilise existing comprehensive data sets of vegetable consumption that has been captured in Australian hospitals and some military bases. If these are accessible and of the 'high' expected quality, it would be recommended to look to baseline here first, developing a consistent approach and model to leverage across other institutions and then potentially other out-of-home settings. Operational constraints within institutions might limit data collection times/ methods and standardising metrics across diverse settings is crucial for accurate comparisons. There will be opportunity in partnerships with foodservice providers and industry bodies (which are essential for large-scale data access and buy-in), and data obtained can be analysed to identify common threads (as well as then informing interventions).
Factors influencing vegetable consumption in this setting:	• Menu offerings and policies (availability, variety, pricing (where applicable), and promotion of vegetables.) Institutional procurement policies shape this significantly. • Cost constraints play a significant role, potentially limiting fresh produce due to the institutional budgets likely in place • Minimum nutritional requirements exist (to align to regulatory standards), but may not emphasise the importance of vegetable intake. • Individual Preferences.
Potential partners for working group:	• Compass and/or Bidfood Australia (or other large wholesale foodservice group) • Industry associations • AerVision

Appendix 2E6

Foodservice Commercial

A business or other entity that provides food and beverages for consumption outside of the home - for example restaurants, pubs, QSR, food trucks, cafes.

Key statistics and background on setting:	This setting is entirely decentralised with a highly diverse customer base, influenced by restaurant type, location, and price point. meal type). Types of Establishments: • Full-service restaurants: Fine dining establishments, casual dining chains, and ethnic restaurants. They typically offer a waiter service, with a menu of prepared dishes. • Quick-service restaurants (QSRs): Fast food restaurants, coffee shops, and other places where customers order and pay for food at a counter, and receive it quickly. • Limited-service restaurants; places like cafes and cafeterias that offer a more limited menu than full-service restaurants, but may still have some table service. • Catering operations: These businesses prepare and deliver food for events, such as weddings, conferences, or office lunches. • Drinking establishments: This includes bars, pubs, nightclubs, and other places that primarily serve alcoholic beverages, but may also offer food. Food Provision Characteristics: • Highly variable menu offerings, price points, and emphasis on fresh vegetable use. • Commercial kitchens with varying levels of centralised procurement. Frequency of Eating Out by Meal: • Dinner: Over 50% of Australians eat out for dinner at least once a week. • Lunch: Approximately of Australians 30-40% eat out for lunch at least once a week. • Breakfast: About of Australians 15-20% eat out for breakfast at least once a week. Popularity of Different Cuisines: Italian, Chinese, and Thai cuisines rank high in popularity amongst Australians. However, there's a growing interest in exploring a wider range of international flavours.
What should be considered as a representative sample and who are major providers of service/ support in area?	A representative sample should stratify across restaurant types, chains, price points, cuisines, locations and capturing independent establishments and large chains and should also consider geographic distribution (urban, regional) and price points. Major providers of service/ support for data and model design will include: • Restaurant representatives such as individual owners / large chain executives • Food Suppliers and Distributors: (e.g. Bidfood, PFD, Marley Spoon) • Industry Associations (e.g. Restaurant and Catering Australia) • Large-chain restaurants groups (including QSR's and more traditional restaurant/pub groups such as Merivale, Australian Venue Co., Seagrass, Solotel and Dixon Hospitality) • Researchers specialising in consumer food choices, food Marketing and menu design • Nutrition professionals and public health experts International data to support/leverage in similar studies • Studies on commercial food consumption patterns, methods to extrapolate vegetable intake from sales data are potentially valuable.
Considerations in designing data framework /model for a baseline:	Designing a data framework model for baseline vegetable consumption in commercial food service settings will present various challenges. Sales records, menu analysis, and ingredient lists offer valuable insights, while "proxy" items (e.g. salads) provide potential indicators of vegetables incorporated into meals too. Targeted surveys focused on dining frequency and food choices can supplement these methods, enriching the consumption picture. A robust data framework for this domain must capture several key elements: • Understanding vegetable supply chain and procurement patterns at the wholesale level. • Menu analysis thorough examination of menu offerings to identify vegetable-based dishes and portion sizes. • Analysis of sales data to track the popularity of vegetable-centric dishes. • Incorporating food (and specifically vegetable) waste audits • Targeted surveys to gauge consumer preferences, dining habits, and awareness of vegetable intake. There will be challenges in inconsistent record-keeping, variations in portion sizes, and the complexity of mixed dishes. Data privacy and the potential burden on businesses must also be navigated. Partnerships with food suppliers, researchers, and receptive large-chain restaurants (that have a wide/large enough footprint) can facilitate data access and streamline the research process. Utilising AI to analyse menu data, plate photography and customer footprints should also be considered.
Factors influencing vegetable consumption in this setting:	• Menu design and availability, including variety, prominence and pricing of vegetables / meals that include vegetables. • Ensuring a representation of various cuisines and menu styles for a comprehensive understanding of vegetable consumption patterns. • Consumer Preferences (i.e. health consciousness vs. indulgence behaviours and culinary trends). • Marketing and promotion on vegetable-rich dishes or less healthy options. • Portion sizes and side dishes influence the overall amount of vegetables consumed.
Potential partners for working group:	• Compass • Bidfood Australia (or other large wholesale foodservice group) • AerVision

Appendix 2E7

Aged Care

A person aged 65 or over that resides in non-private dwellings provide communal or short-term accommodation - such as an aged care facility. This cohort includes those aged 65+ who reside by themselves or with a spouse or partner in a private dwelling.

Key statistics and background on setting:	Types of Aged Care: • Home Care: Support within an individual's residence. • Residential Care: 24/7 care in facilities (nursing homes, assisted living). • Short-term Care: Temporary, often post-hospitalisation or respite. Population Characteristics: • Typically 80+, high frailty, potential cognitive decline, and a higher proportion of women. • Health conditions affecting food intake are common (e.g., dysphagia, limited mobility). Provider mix: Government, not-for-profit, private providers, etc.
What should be considered as a representative sample and who are major providers of service/ support in area?	• Stratifying the population across care types (home vs. residential), provider types and facility sizes, and geographic locations (urban, regional, remote). • There is the potential to work with experts in Aged Care Food Waste and then utilise this data with procurement teams on supplied food / meals to create a calculation baseline. Major providers of service/ support for data and model design will include: • Large, aged care providers (e.g., Bupa, McKenzie Aged Care Group), contracted food service providers (e.g., Compass), Procurement managers, Dietitians Australia, and relevant research institutions likely possess valuable information. • Industry Associations (e.g. Aged and Community Services Australia) • Researchers specialising in gerontology and nutrition, and food provision in aged care • Dietitians Australia • Government Agencies (Department of Health and Aged Care)
Considerations in designing data framework /model for a baseline:	Consumption data capture presents challenges in aged care. Direct observation can be intrusive, which will put reliance on procurement records, thorough menu analysis, meal audits, and objective plate waste measurements. To validate these methods and account for individual variation, supplementing with food diaries (where feasible) and tailored dietary assessments would be beneficial and utilising AI or photo recognition (through Aged Care staffing), would also be ideal. Establishing a robust data framework in Aged Care will likely require collection across several elements, including: • Procurement records to track vegetable purchases and understand the initial inflow to the setting. • Examination of menu offerings to identify vegetable-based dishes and portion sizes. • Regular meal audits served to assess alignment with planned menus. • Quantifying plate waste to determine actual consumption versus served portions. • Individualised assessment through use of food diaries, interviews or dietary assessments for a subset of residents to validate other methods and capture potential variations in intake. Challenges will include adhering/upholding ethical approvals and privacy regulations and the collection of data (potentially time-consuming and resident cognitive ability and participation may vary). Strong partnerships with aged care providers, researchers, and dietitians are crucial for successful implementation and data analysis. A well-designed pilot study will provide valuable insights into feasibility and allow for refinements before a large-scale rollout. A potential opportunity exists to leverage existing consumption datasets captured within a large Australian aged care provider. At the time of writing of this report, these datasets were not viewed but if they are made accessible and meet the required quality standards, it is advisable to establish a baseline analysis here and have this utilised within horizon one. This data had been captured through photographs or plated food pre and post consumption that is weighed and analysed using machine learning to identify the foods on the plate (including vegetables).
Factors influencing vegetable consumption in this setting:	• Menu standards, procurement practices, emphasis on fresh produce. • Individual needs and preferences (chewing/swallowing difficulties for elderly, food aversions, personal choice (though this may be limited in higher-care settings)). • Appetite, eating habits, medical conditions, medications, and overall food intake. • Food presentation and mealtime assistance (can cause a variation in intake in those with impairments) • Special diets (i.e. texture modified diets (pureed) are common, impacting vegetable forms)
Potential partners for working group:	• Lantern Alliance • Dietitians Australia • Southern Cross Care • Opal HealthCare • AerVision • Compass

Appendix 2E8

Food Relief

Relief is a response by an organisation (including charities and government) for those in acute need but is also used to meet the needs of people facing chronic food insecurity. For example, FoodBank, OZHarvest, FairShare, SecondBite.

Key statistics and background on setting:	• Public food relief comes from: Government assistance (e.g. Centrelink), school lunch programs. • Private food relief typically comes from: Food banks, soup kitchens, charities • Food banks work with partner charities and frontline services that then distribute food hampers, provide hot meals, or offer community food programmes. Foodbank, (Australia's largest food relief organisation) supports over a million Australians each month. • Beneficiaries commonly include low-income households, fixed-income recipients, unemployed individuals, families facing hardship and elderly. • Food insecurity is a significant issue in Australia. • The number of people using food relief can fluctuate depending on economic conditions, natural disasters, and policy changes.
What should be considered as a representative sample and who are major providers of service/ support in area?	The food relief setting is somewhat 'centralised'. It will be important to stratify across food relief types (food banks, soup kitchens, school programs), geographic regions (urban, regional, remote) and recipient demographics to build a representative sample. The Food Relief setting is also significantly underrepresented, with an estimation of over a third of food-insecure Australians not accessing food relief due to factors like stigma and accessibility. Major providers of service/ support in setting: • National Food Relief Networks including Foodbank and SecondBite • Local Charities and Frontline Services • Researchers specialising in food insecurity and nutrition • Public health and social welfare programs • Government Agencies (Department of Social Services) • Large industry Partners in Grocery stores, farms, food rescue organisations Working with procurement managers and meal planning teams within these groups will be beneficial in understanding consumption.
Considerations in designing data framework / model for a baseline:	A combination of self-reporting by recipients, analysis of distribution records, and the use of proxy indicators like the proportion of fresh produce distributed provide valuable, albeit imperfect, insights in this setting. For a proposed data framework model; it will likely include: • Recipient surveys (across types of people who have access to food relief), understanding frequency of food relief use, types of foods typically received, and estimates of vegetable consumption. • Analysis of records of types and quantities of food distributed • Focus group sessions with recipients and food relief staff to gain a deeper understating or access, preparation and consumption patterns. Challenges lie in the inconsistencies in data collection and limitations in accuracy of self-reporting. Privacy considerations too have the potential to burden on recipients so these must be carefully addressed. Partnerships with food banks, charities, and researchers will enhance data collection and analysis efforts. This type of research has the potential to inform targeted interventions to increase vegetable access and consumption among vulnerable populations which should aid as a reason to ensure participation and collaboration in the work involved.
Factors influencing vegetable consumption in this setting:	• Reliance on donations means less control over the types of food received, potentially limiting fresh vegetable intake. • Storage and distribution challenges (i.e. perishability of fresh produce adds logistical hurdles) • Recipient preferences may impact vegetable consumption. • Focus on hunger alleviation (providing basic calories may take precedence over balanced nutrition initially). • Stigma challenges - recipients may be reluctant to participate in data collection due to the perceived stigma of needing food assistance.
Potential partners for working group:	• Food Bank • Oz Harvest • FareShare • Second Bite

Appendix 2E9

Recommended Data Framework

The following data framework is recommended for future updates of the current bottom-up baseline model. This framework has been designed around the start schema model and aims to ensure data modelling robustness and consistency as the Plus One Serve program progresses in the following years.

It is recommended that future data requests for the current model and for subsequent models (e.g. potential models for out of home settings) to follow this framework.

The specific framework is outlined below:

Metrics required:

- Volume of vegetables (measures in grams, kilograms or tonnes) – both supply and waste
- Average unit price (optional – to be used in economic impact analysis, if any)
- Segmented by individual vegetable categories (as covered in Appendix 2A) and follow the rules outlines in the **Project scope & boundaries** section of this report. this would namely include:
    - Fresh
    - Frozen
    - Dried / Dehydrated
    - Canned
    - Products where vegetables are a major component (e.g. high 'serve' claim Dari's Soup On-the-Go, Campbell's Real Soup, etc.)
    - Categories defined as part of the original National Health Survey
    - Legumes
    - Tomatoes
    - Vegetable juice
    - Vegetable snacks (excl. those that are fried, processed)

    This would exclude:
    - Fermented
    - Pickled
    - Products where vegetables are a minor component (e.g. pizza, burgers, etc.)
    - Processed potato products (e.g. chips, fries, etc.)
    - Vegetables oils or flours

Timeline required:

- As granular as possible – ideally at daily level (aggregation to a monthly or yearly format can be done during the modelling process as needed)
- Annual or every two years – depending on the frequency of data collection

Dimensions required:

- Anonymised household (or participant) ID
- Geographic information:
    - State
    - Remoteness region

- Socioeconomic information:
  - Household income (weekly or annually) before tax
  - Family setting or life stage
- Demographic information:
  - Number of persons in the household
  - Sex
  - Age

  The above information should ideally be extracted for each individual in the household. If not available, demographic information of the person making purchasing decisions for the household should be captured.

Data structure required:

As an overall rule, vegetable supply and waste for home scan data should be extracted at the **household** level, along with any household information. This ensures that consumption can be calculated and cross-tabulated between any household characteristics.

As an example, the requested data could exist in the following format:

Dataset 1: Vegetable-related metrics (supply)

Anonymised household ID	Date	Vegetable category	Volume purchased (grams)	[Optional – other metrics which can enrich understanding of consumption haviour]
ABC123	01/01/2025	Broccoli	300	*e.g. purchase source*
…	…	…	…	…

Dataset 2: Vegetable-related metrics (waste)

Anonymised household ID	Date	Vegetable category	Waste description	Volume wasted (grams)	[Optional – other metrics which can enrich understanding of consumption haviour]
ABC123	01/01/2025	Broccoli	Stem, inedible	100	*e.g. waste disposal method*
…	…	…		…	…

Dataset 3: Household-related information

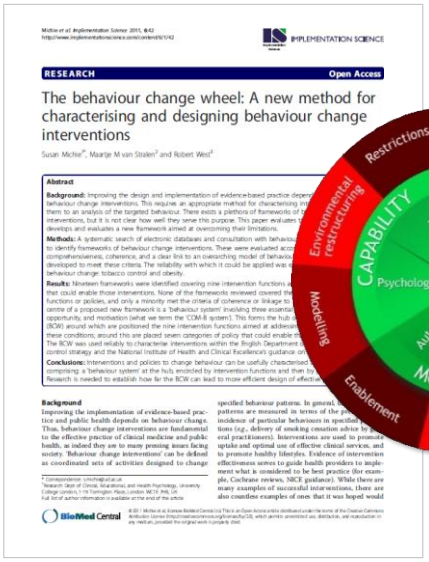
Anonymised household ID	No. persons in HH	State	Region	HH Income (AUD p.a.)	Sex of HH purchaser	Age of HH purchaser	HH characteristic	…
ABC123	4	VIC	Remote	150,000	Male	30	Start-up family	…
…	…		…	…	…	…	…	…

From this example structure, vegetable-related data and household characteristics can be linked via the anonymised household ID. Consumption can be cross-examined across all household characteristics (economic, geographic, demographic, etc.).

7.3 Appendix – Module 3

Appendix 3A

Michie et al. *Implementation Science,* 2011

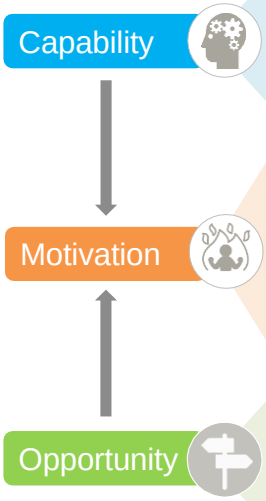


Based on a 2011 Systematic review – the BCW incorporates elements of **19 behaviour change frameworks** into a single **comprehensive** and **coherent** tool, linked to an **overarching model of behaviour**[1]

It links identified **sources of behaviour** to appropriate **intervention functions**, in order to guide the selection of **behaviour change techniques (BCTs)** and the design of effective interventions

It has been used to design and evaluate a range behaviour change intervention programs across health (preventions, nutrition, exercise, smoking cessation), road safety, environment water conservation,

Figure 43 The behaviour change wheel



COM-B components	Theoretical Domains Framework
Physical capability physical skill	▪ Physical skills
Psychological capability The capacity to engage in the necessary thought processes - comprehension, reasoning	▪ Knowledge ▪ Cognitive and interpersonal skills ▪ Memory, attention and decision processes ▪ Behavioural regulation
Reflective motivation Beliefs about what is good and bad, conscious intentions, decisions and plans	▪ Professional/social role and identity ▪ Beliefs about capabilities ▪ Optimism ▪ Beliefs about consequences ▪ Intentions ▪ Goals
Automatic motivation Emotional responses, desires, impulses and habits resulting from associative learning and physiological states	▪ Reinforcement ▪ Emotion
Physical opportunity Opportunity afforded by the environment	▪ Environmental context and resources
Social opportunity Opportunity afforded by the cultural milieu that dictates the way that we think about things	▪ Social influences

Figure 44 The Com-B model

Appendix 3B

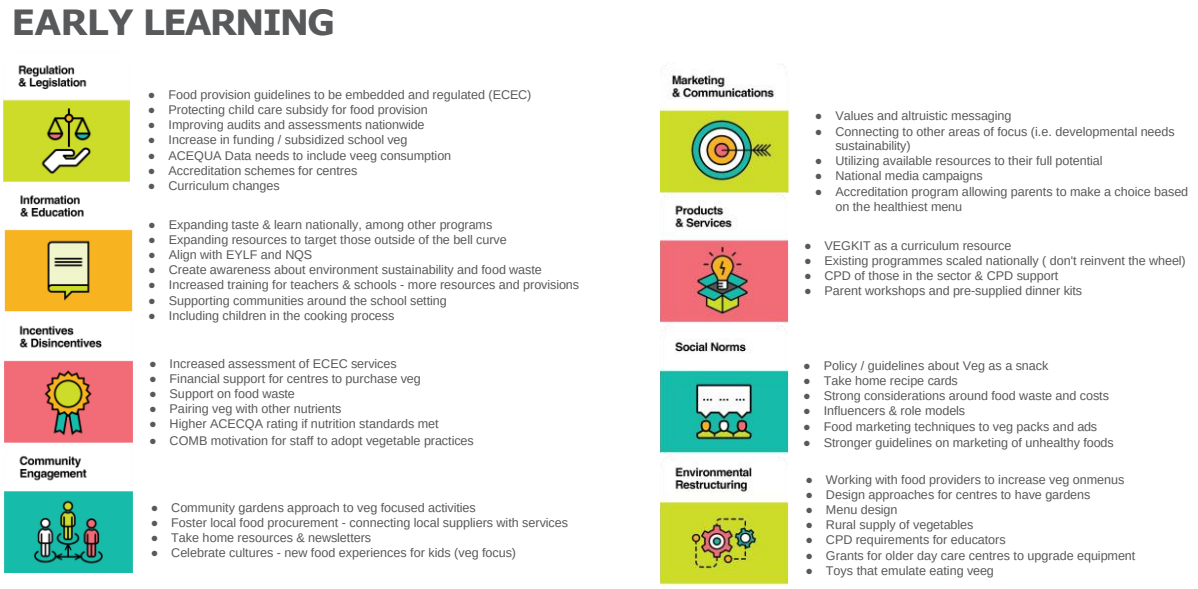


Figure 45 Summary of workshop outcomes for Early Learning setting

Programs highlighted by participants include:

- 'Study Protocol of the Parents in Child Nutrition Informing Community (PICNIC) Peer Education Cohort Study to Improve Child Feeding and Dietary Intake of Children Aged Six Months to Three Years Old', CHILDREN-BASEL, 7 (2020)

Appendix 3C

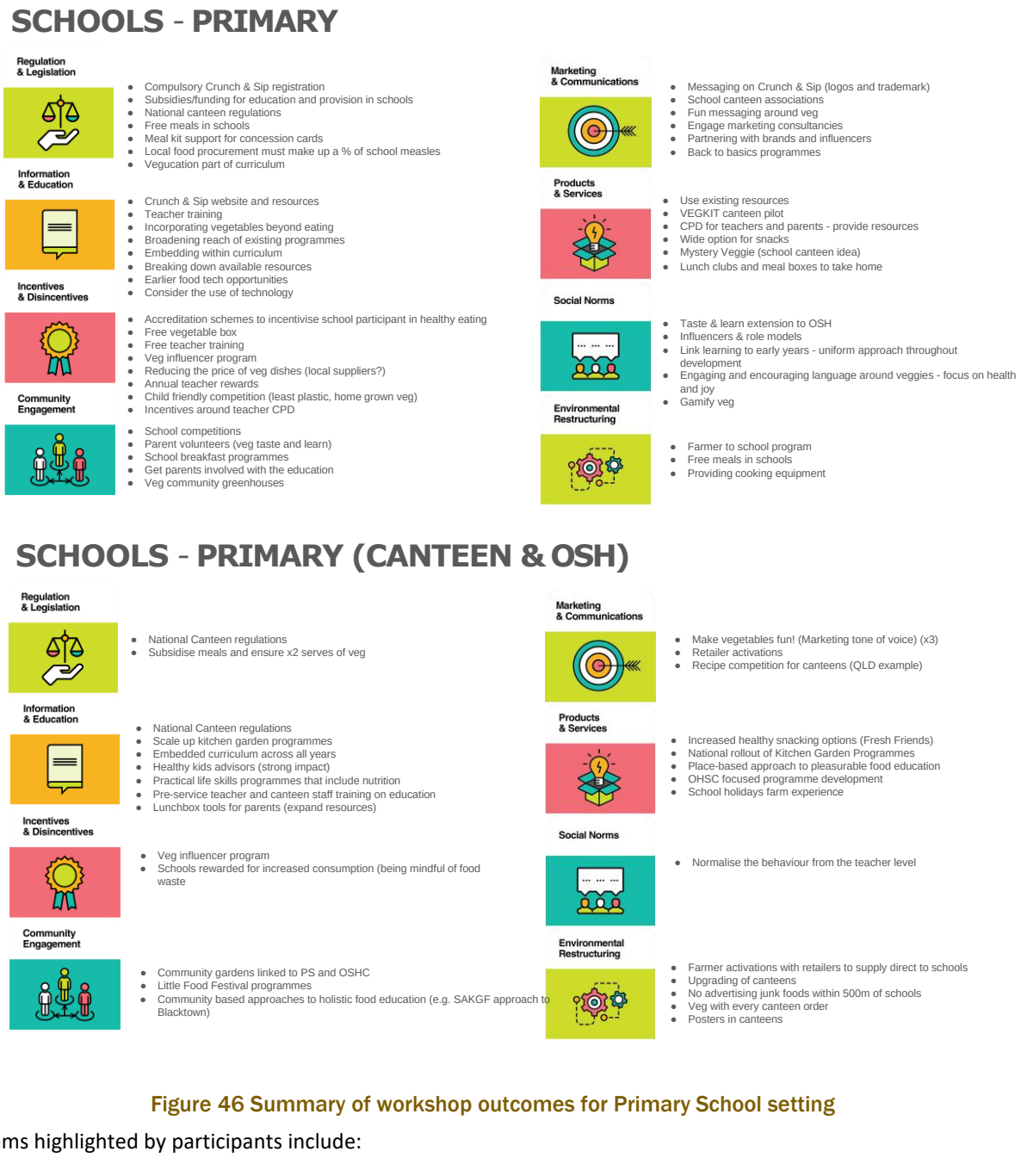


Figure 46 Summary of workshop outcomes for Primary School setting

Programs highlighted by participants include:

- Place -based projects (e.g. Healthy Kids Advisor initiative) https://www.kitchengardenfoundation.org.au/healthy-kids-advisors working alongside community to change up offerings at schools, canteens, community settings, OHS, etc. etc. evaluations show had 5x impact .This initiative won't be continued past June 30 by Fed or State Govt.
- 2010 Crunch and Sip Evaluation report - https://www.crunchandsip.com.au/assets/downloads/2012-04-10-crunchsip-audit-report.pdf
- 2019 Crunch and Sip Evaluation report - https://www.crunchandsip.com.au/assets/evaluation/crunchsip-report_final.pdf
- Food Literacy - which the participants acknowledged needs to be expanded https://www.sciencedirect.com/science/article/abs/pii/S019566631400018X?via%3Dihub
- Environment as a motivator for vegetable consumption https://www.pnas.org/doi/10.1073/pnas.2204241119

- School promotional programs and parent's perspective: https://transformus.com.au/ & https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-021-11813-6 & https://ro.ecu.edu.au/cgi/viewcontent.cgi?article=5527&context=ajte& https://www.cambridge.org/core/services/aop-cambridge-core/content/view/F46F5A901D4E8CC8D00A927BC9CF94E7/S1368980023002240a.pdf/parental_support_for_free_school_lunches_in_australian_primary_schools_associated_factors_and_perceived_barriers.pdf
- https://www.contagious.com/news-and-views/campaign-of-the-week-delhaize-the-vegetable-name-change
- https://www.sciencedirect.com/science/article/pii/S266637402100056X & https://pubmed.ncbi.nlm.nih.gov/36104738/ & https://pubmed.ncbi.nlm.nih.gov/36907518/
- A Health and Wellbeing Queensland game/app for kids: Podsquad – Health and Wellbeing Queensland (hw.qld.gov.au) &
- A Health and Wellbeing Queensland program building capability and connecting women and communities https://qcwacountrykitchens.com.au/ &
- A Health and Wellbeing Queensland Kids School program connecting kids with growers and community https://hw.qld.gov.au/pick-of-the-crop/ &
- Disadvantaged groups https://link.springer.com/article/10.1007/s10995-023-03849-4
- Edith Cowan University Year 6 to 9 gaming education resource https://www.ecu.edu.au/schools/education/research-activity/innovation-in-policy-and-practice/related-content/lists/projects/farm-to-fork-video-game-to-help-adolescents-understand-bare-supermarket-shelves
- WA advisory resources for schools https://www.freshsnap.org.au/ & https://myresources.education.wa.edu.au/programs/primed-overview

Appendix 3D

SCHOOLS - SECONDARY & TERTIARY

Regulation & Legislation

- Vegucation across multiple learning areas
- Policy on canteen reform
- CPD for teachers in regulation
- Mandatory veg per meal
- AMA/RACGP support and overall curriculum changes
- Price ceiling for veg
- National consistent regulations on healthy marketing
- Charters around vending machines/what can be sold

Information & Education

- Wide scope for food tech (modernise)
- Link food to mood
- Farm to school and dietitian programs
- Experiential learning
- Extend TransformUs - look into Dutch programme ("Taste Lessons")
- Bolt on to programmes (don't make new ones!)
- Develop curriculum

Incentives & Disincentives

- Cheaper veeg focused meals in canteens
- Sponsoring programmes to incentivise inclusion in curriculum
- Encourage student led initiatives (competitions?)
- Food Tech home challenges
- Price discounts at stores (not just for food)
- School canteen points system (more veg = more points)

Community Engagement

- Projects to establish local small scale farms
- School tours to farms
- Celebrity chef tours
- Technology
- Upgrading facilities
- Including students in ideas
- Engage homie economics Australia (they are in this space)

Marketing & Communications

- Celebrity chefs
- Research what drives teens with lowest consumption
- Social media campaign (tik tok)
- Increase profile of home economics courses

Products & Services

- Veggies to be used in food tech
- Nutrition app
- Appeal retail innovations into packed lunches
- Breakfast clubs
- Direct grower partnerships
- Veggie growing challenges
- Experimental learnings
- Scale existing programmes

Social Norms

- War on waste
- Bottom up approach (looking at social media trends)
- Vegetables present at all school events
- Regular farm visits

Environmental Restructuring

- Innovative food marketing practices at tuckshops/canteens
- Fast food a required distance from schools
- Schools veg market (selling on produce)
- Removal of processed food in schools
- CPD teacher support
- Survey students - what do they want?

Universities and Tafe

Regulation & Legislation

- Better standards for healthy canteens (regulation)
- National free lunch program
- University policies on what is sold ono campus

Information & Education

- Life transitions (key movement in Uni careers to target)
- TAFE courses
- STEM programs to link with horticulture /farms
- Responsive resources
- Teacher resources / upskilling
- university /farm relationships

Incentives & Disincentives

- Subsidies for healthy food and drink - veg based

Community Engagement

- Cooking on country (bush foods)
- Community gardens /veg hubs
- Market days on campus
- celebrity chef /wellbeing visit

Marketing & Communications

- wellbeing messaging including veg based nutrition
- climate based messaging on climate diet
- faculty/club based messaging motivating veg based nutrition

Products & Services

- Veg kits and boxes delivered at uni
- Applications and technology to support
- uni app based loyalty programs /price discounts
- integration of student discounts for veg in retailer/delivery service apps

Social Norms

- Health and wellbeing are important to this demographic - key focus on this in messaging
- Reduce stigma around veg

Environmental Restructuring

- Capacity to use AI?
- Community garden as hub for education and access
- food retail on campus to promote veg based nutrition and food kits

Figure 47 Summary of workshop outcomes for Secondary & Tertiary settings

Appendix 3E

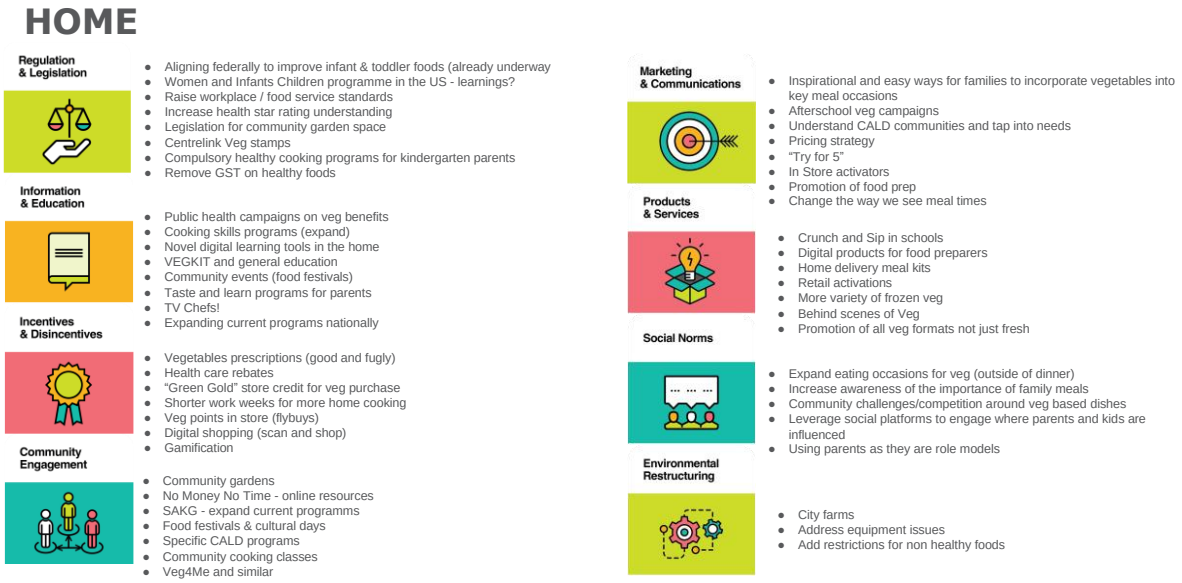


Figure 48 Summary of workshop outcomes for Home setting

Programs highlighted by participants include:

- https://theconversation.com/hate-vegetables-you-might-have-super-taster-genes-74428

Appendix 3F

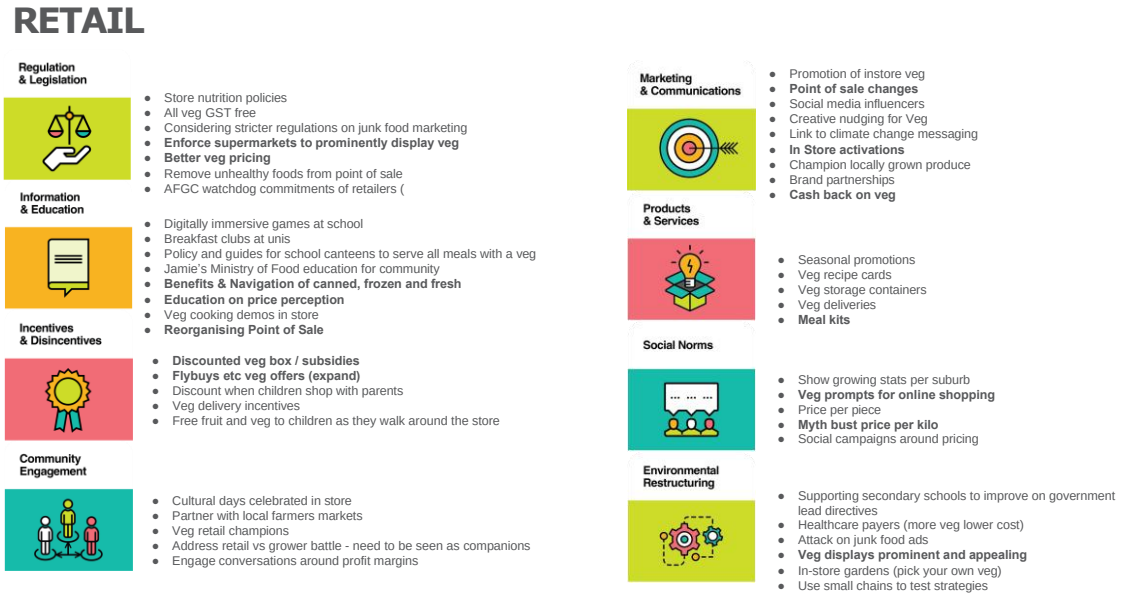


Figure 49 Summary of workshop outcomes for Retail setting

Programs highlighted by participants include:

- The need to meet rural/remote audiences -indigenous specifically - where they are. Healthy Stores in remote and indigenous areas was referenced: https://healthyfoodretail.com/resource/healthy-stores-2020-policy-action-series-healthy-policy-to-support-retailers-and-communities/

Appendix 3J

Details of 'Plus One' Behavioural Intervention Framework

Behavioural Intervention Strategy Plan

Policy – Every successful sustained behaviour change is underpinned by focused and positive policy that helps over come barriers and helps motivate individuals embrace the desired behaviour – eating one more serve of veg.

Barrier/ Motivator	Accessibility /Perceived Value	Taste and enjoyment	Knowledge and skill	Convenience and ease	Quality and Variety	Waste and shelf life	Wellbeing and environment
Objectives	Foundational pricing policy for retail setting to aid value and affordability assessment – e.g., cost per serve. Policy to guide accessibility for all Australians including low SES, indigenous and rural and remote audiences	Foundational Policy across education settings guiding - Curriculum to improve knowledge and skill essential to enjoyment - Good food provisioning through canteens - Accessibility across all audiences especially Low SES, indigenous and food insecure to aid in provisioning of key meals			Policy to support R&D exploration for new variants that improve taste , shelf life et al. Policy that set quality standards and nutritional disclosure.		
Audiences	Federal, State and Territory Governments						
Partners/ Advocates	Producers/manufacturers/Retailers/AMA/RACGP/ Health insurers/NFP / food influencers, educators and cultural and indigenous leaders.						
Enabler(s)	Compelling social and economic benefit case and narrative consistently and collaboratively prosecuted by veg sector partners, advocates and academics.						

Behavioural Intervention Strategy Plan

Vegetable Communication – consistent communication under one "active brand' framework, tailored to settings and audiences is essential to drive long term, sustained behaviour change

Barrier/ Motivator	Accessibility /Perceived Value	Taste and enjoyment	Knowledge and skill	Convenience and ease	Quality and Variety	Waste and shelf life	Wellbeing and environment
Objectives	Across all consumer audiences greater accessibility and skill in determining personal value of vegetables as a tasty, enjoyable, energizing and health food across all meal/snack occasions	Consistent presentation of inspiration of vegetables as tasty and enjoyable for all across all meal/snack occasions and providing an easy pathway to achieving success in preparing vegetables	Provide easy to access and use information and education that builds knowledge and skills on how to prepare tasty and enjoyable vegetables easily and at relatively low cost.	Provide continual reinforcement and simple hacks that increases ease of preparation build increased appreciation of the convenience of vegetables .	Provide information, education and inspiration of vegetables across the seasons and varieties that enhance the taste enjoyment and affordability of vegetables	Provide targeted information, knowledge and skill to minimise waste through storage and hacks for leftovers, building taste and enjoyment as well as improved value perception	Increase appreciation and knowledge of the greater wellbeing benefits of vegetables – physical and mental health. Leverage the motivational power of environmental benefits to eating more vegetables
Audiences	Mass and targeted programs across SES, CALD, indigenous and metro and regional/remote Setting based programs - ECES, Primary and OSCH, secondary and Tertiary, Home and Retail						
Partners/ Advocates	Producers/manufacturers/Retailers/AMA/RACGP/ Health insurers/NFP / food influencers, educators, media owners and program creators						
Enabler(s)	Unifying brand –consistent across settings, messages and audiences , Collaborating partners embracing and consistently presenting the brand and messages across all platforms and channels						

Behavioural Intervention Strategy Plan

Information & Education – highly accessible and easy to engage information and education is essential to building the capability of individuals to consume more veg.

Barrier/ Motivator	Accessibility /Perceived Value	Taste and enjoyment	Knowledge and skill	Convenience and ease	Quality and Variety	Waste and shelf life	Wellbeing and environment
Objectives	Provide information and education in a manner that is tailored to audience and way that is highly accessible and shareable - face to face in setting or via digital tools	All information and education should reinforce and inspire audiences of the tastiness of vegetables across all occasions that are enjoyed by all	Provide easy to use and access through preferred channels information and education that enhances an individuals knowledge and skill to enjoy vegetables	Provide easy to use and access through preferred channels information and education that highlights and build skills tot eh ease of vegetable preparation.	Provide easy to uses and access through preferred channels and P.O.S information and education that builds and individual's skill in choosing veg that will ensure they have a tasty and more enjoyable experience.	Provide easy to uses and access through preferred channels and P.O.S information and education that helps people minimis waste through better choice, storage and use of leftovers	Provide easy to use and access through preferred channels information and education that builds appreciation of the benefits of more veg consumption on individuals' total wellbeing , including meat health and the environment
Audiences	Mass and targeted programs across SES, CALD, indigenous and metro and regional/remote Setting based programs - ECES, Primary and OSCH, secondary and Tertiary, Home and Retail						
Partners/ Advocates	Producers/manufacturers/Retailers/AMA/RACGP/ Health insurers/NFP / food influencers, educators, media owners and program creators						
Enabler	Unifying brand –consistent across settings, messages and audiences , Collaborating partners embracing and consistently presenting the brand and messages across all platforms and channels						

Behavioural Intervention Strategy Plan

Products and services – the continual innovation of vegetable products and services that improve the taste, enjoyment and ease with which that can be achieved across all meal and snack occasions is instrumental in long term sustained change.

Barrier/ Motivator	Accessibility /Perceived Value	Taste and enjoyment	Knowledge and skill	Convenience and ease	Quality and Variety	Waste and shelf life	Wellbeing and environment
Objectives	Innovative products and services that enhance way all audiences can access vegetables and the ease with which they can evaluate and increase the perceived value of veg	Improved products, produce and services – digital or f2f that increase an individuals taste and enjoyment experience of vegetables across all meal and snack occasions	Improved access to products, produce and services – digital or f2f across all settings so that individuals can build physical and psychological capability to buy and enjoy vegetables more.	products, produce and services – digital or f2f across all settings that make it easy and convenient to buy, prepare and enjoy vegetables across all meal and snack occasions.	Products and services at point of sale (online or instore) that make it easy to select vegetables that will enhance enjoyment and improve value perceptions.	Products and services for the home that help individuals reduce waste through better storage , prolong shelf life and provide hacks to using leftovers	Provide highly accessible and easy to use information that enhances our appreciation of how vegetables can be part of an individual's contribution to environment and how they can improve our mental health as we as physical wellbeing
Audiences	Mass and targeted programs across SES, especially low SES, CALD, indigenous and metro and rural /remote. Health professionals, influencers						
Partners/ Advocates	Producers/manufacturers/Retailers/AMA/RACGP/ Health insurers/NFP / food influencer, entrepreneurs, Tech media (e.g., Chef GPT)						
Enabler	Unifying brand –consistent across settings, messages and audiences , Collaborating partners embracing and consistently presenting the brand and messages across all platforms and channels						

Behavioural Intervention Strategy Plan

Food Environmental Restructuring – interventions designed to make it easier to engage with, choose and enjoy vegetables

Barrier/ Motivator	Accessibility /Perceived Value	Taste and enjoyment	Knowledge and skill	Convenience and ease	Quality and Variety	Waste and shelf life	Wellbeing and environment
Objectives	Bring people close to the whole experience from farm, growing to point of sale to increase the valuing of vegetables beyond price.	Increase appetite appeal and enjoyment and satisfaction of the vegetable experience through growing within setting, farmer engagement , instore /online. engagement	Improve the knowledge people have of vegetables through deeper experiences via growing within setting, farmer engagement , instore /online. engagement	Packaging and presentation of vegetables that make preparing and buying easier.	Enhance presentation of vegetables and new varieties so they are appetising and highly accessible online and instore	Provide 'in setting' affordable solutions to prolong shelf life and reuse leftovers that ensure enjoyment and increase value perceptions. Especially for space deprived homes	Enhance personal wellbeing through the physical engagement with vegetables, gardens and farmers.
Audiences	Retailers of veg and garden supplies Educators and local councils Homes and garden suppliers/retailers						
Partners/ Advocates	Producers/manufacturers/Retailers// /NFP / food influencers/ garden influencers/ educators/local councils						
Enabler	,Collaborating partners embracing and consistently trialing ways to improve the presentation of vegetables Setting based providers of materials that help in physical restructuring - e.g., Bunnings						

Behavioural Intervention Strategy Plan

Value and Incentives are key motivators in triggering the initial behaviour " one more serve of veg" and for reinforcing behvaviour and creating new positive habitual behaviour .

Barrier/ Motivator	Accessibility /Perceived Value	Taste and enjoyment	Knowledge and skill	Convenience and ease	Quality and Variety	Waste and shelf life	Wellbeing and environment
Objectives	Increase perceived value of veg through greater understanding and appreciation of comparative costs to performing the desired behaviour	Increase propensity to trial and then reward behaviour of consuming more veg.	Increase propensity to engage in education sessions or seek information to build capability to prepare tasty and enjoyable vegetables. Act as a reward and nudge to continual capability building resources	Trial new hacks and variants that improve the ease and convenience of preparation, Reward repeated behaviour	Incentive to trial new variants that improve the taste and enjoyment experience and/or improve the affordability and value perceptions of vegetables. Reward repeated behaviour.	Trial new, better ways to store vegetables and hacks to reuse leftovers or older veg.	Incentives and rewards designed to engage emerging motivators such as mental health and the environmental benefits
Audiences	Mass and targeted programs across SES, especially low SES, CALD, indigenous and metro and rural /remote. Health professionals, food and health influencers						
Partners/ Advocates	Producers/manufacturers/Retailers/AMA/RACGP/ Health insurers/NFP / food and wellbeing influencers						
Enabler	Unifying brand –consistent across settings, messages and audiences , Collaborating partners embracing and consistently presenting the brand and messages across all platforms and channels						

7.4 Appendix – Module 4

Appendix 4A

Consumption change data inputs by setting

Table A.1 Benefit assumptions for the Early Years setting

Modelling input name	Modelling input values				Source / comment
	Low	Mid	High	Optimal	
Target population	1.85 million (ages 0-5 years in 2024), with projected growth of 0.6% per year to 2034.	1.85 million (ages 0-5 years in 2024), with projected growth of 0.6% per year to 2034.	1.85 million (ages 0-5 years in 2024), with projected growth of 0.6% per year to 2034.	1.85 million (ages 0-5 years in 2024), with projected growth of 0.6% per year to 2034.	Total focus cohort of ages 0-5 years. Population data from ABS 3101). See *Appendix A. Baseline Projections*.
Target reach by year (by year of investment)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 20% (scaling) Year 6+ 50% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 40% (scaling) Year 6+ 75% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 60% (scaling) Year 6+ 100% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 40% (scaling) Year 6+ 75% (at scale)	The speed of reach/adoption would reflect the speed of rollout, in turn reflecting the size of the underlying investment resources and supporting elements (e.g. government policy). Assumption based on R&D and pilot phases, then a "hockey stick" rapid scale up with maximum scale achieved by 2030 (year 6).
Maximum setting consumption change (serves/person/day)	+0.14 x 0.5 = +0.07 (-50% of Rapid Review)	+0.14 (Rapid Review)	+0.14 x 1.5 = +0.21 (+50% of Rapid Review)	+0.14 (Rapid Review)	CSIRO Rapid Review (Module 1) identified a single review. This was adjusted for an assumed low and high figure by ±50% as part of the VG23005 Scenario Workshop (Module 3).
Timeline of setting consumption change (by year of first exposure)	Year 1 50% Year 2 75% Year 3 100% Year 4+ 100%	Year 1 75% Year 2 100% Year 3 100% Year 4+ 100%	Year 1 100% Year 2 100% Year 3 100% Year 4+ 100%	Year 1 75% Year 2 100% Year 3 100% Year 4+ 100%	The speed of behaviour/consumption change could reflect the intensity of the interventions, in turn reflecting scenario resources and intervention mix. 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.
Concurrent (program) cumulative effect	1.00	1.25	1.50	1.25	See ***Error! Reference source not found.*** *1 – program effects on consumption*
Sequential (time) cumulative effect	1.00	1.25	1.50	1.50	See ***Error! Reference source not found.*** *1 – program effects on consumption*

Table A.2 Benefit assumptions for the Primary School setting

Modelling input name	Modelling input values				Source / comment
	Low	Mid	High	Optimal	
Target population	2.31 million (ages 6-12 years in 2024), with projected growth of 0.3% per year to 2034.	2.31 million (ages 6-12 years in 2024), with projected growth of 0.3% per year to 2034.	2.31 million (ages 6-12 years in 2024), with projected growth of 0.3% per year to 2034.	2.31 million (ages 6-12 years in 2024), with projected growth of 0.3% per year to 2034.	Total focus cohort of ages 6-12 years. Population data from ABS 3101). See *Appendix A. Baseline Projections*.
Target reach by year (by year of investment)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 20% (scaling) Year 6+ 50% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 40% (scaling) Year 6+ 75% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 60% (scaling) Year 6+ 100% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 40% (scaling) Year 6+ 75% (at scale)	The speed of reach/adoption would reflect the speed of rollout, in turn reflecting the size of the underlying investment resources and supporting elements (e.g. government policy). Assumption based on R&D and pilot phases, then a "hockey stick" rapid scale up with maximum scale achieved by 2030 (year 6).
Maximum setting consumption change (serves/person/day)	+0.12 x 0.5 = +0.06 (-50% of Rapid Review average)	+0.12 (Rapid Review)	+0.42 (Rapid Review)	+0.12 (Rapid Review)	CSIRO Rapid Review (Module 1) identified 18 reviews. A minimum consumption change of +0.0 was identified across the reviews. This was revised to -50% of the average as part of the VG23005 Scenario Workshop (Module 3).
Timeline of setting consumption change (by year of first exposure)	Year 1 50% Year 2 75% Year 3+ 100%	Year 1 75% Year 2 100% Year 3+ 100%	Year 1 100% Year 2 100% Year 3+ 100%	Year 1 75% Year 2 100% Year 3+ 100%	The speed of behaviour/consumption change could reflect the intensity of the interventions, in turn reflecting scenario resources and intervention mix. 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.
Concurrent (program) cumulative effect	1.00	1.25	1.50	1.25	See ***Error! Reference source not found.*** *1 – program effects on consumption*
Sequential (time) cumulative effect	1.00	1.25	1.50	1.50	See ***Error! Reference source not found.*** *1 – program effects on consumption*

Table A.3 Benefit assumptions for the High School and Tertiary setting

Modelling input name	Modelling input values				Source / comment
	Low	Mid	High	Optimal	
Target population	4.06 million (ages 13-24 years in 2024), with projected growth of 0.6% per year to 2034.	4.06 million (ages 13-24 years in 2024), with projected growth of 0.6% per year to 2034.	4.06 million (ages 13-24 years in 2024), with projected growth of 0.6% per year to 2034.	4.06 million (ages 13-24 years in 2024), with projected growth of 0.6% per year to 2034.	Total focus cohort of ages 13-18 years (high school ages) and 17-24 years (tertiary ages) with population data from ABS 2023a. See *Appendix A. Baseline Projections*.
Target reach by year (by year of investment)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 20% (scaling) Year 6+ 50% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 40% (scaling) Year 6+ 75% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 60% (scaling) Year 6+ 100% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 40% (scaling) Year 6+ 75% (at scale)	The speed of reach/adoption would reflect the speed of rollout, in turn reflecting the size of the underlying investment resources and supporting elements (e.g. government policy). Assumption based on R&D and pilot phases, then a "hockey stick" rapid scale up with maximum scale achieved by 2030 (year 6).
Maximum setting consumption change (serves/person/day)	+0.15 x 0.5 = +0.075 (-50% of Rapid Review)	+0.15 (Rapid Review)	+0.15 x 1.5 = +0.225 (+50% of Rapid Review)	+0.15 (Rapid Review)	CSIRO Rapid Review (Module 1) identified a single review. This was adjusted for an assumed low and high figure by ±50% as part of the VG23005 Scenario Workshop (Module 3).
Timeline of setting consumption change (by year of first exposure)	Year 1 50% Year 2 75% Year 3+ 100%	Year 1 75% Year 2 100% Year 3+ 100%	Year 1 100% Year 2 100% Year 3+ 100%	Year 1 75% Year 2 100% Year 3+ 100%	The speed of behaviour/consumption change could reflect the intensity of the interventions, in turn reflecting scenario resources and intervention mix. 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.
Concurrent (program) cumulative effect	1.00	1.25	1.50	1.25	See ***Error! Reference source not found.*** *1 – program effects on consumption*
Sequential (time) cumulative effect	1.00	1.25	1.50	1.50	See ***Error! Reference source not found.*** *1 – program effects on consumption*

Table A.4 Benefit assumptions for the Home setting

Modelling input name	Modelling input values				Source / comment
	Low	Mid	High	Optimal	
Target population	27.0 million (total residential population 2024) with project average annual growth of 1% to 2034	27.0 million (total residential population 2024) with project average annual growth of 1% to 2034	27.0 million (total residential population 2024) with project average annual growth of 1% to 2034	27.0 million (total residential population 2024) with project average annual growth of 1% to 2034	Population data from ABS 3101. See *Appendix A. Baseline Projections*.
Target reach by year (by year of investment)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 20% (scaling) Year 6+ 50% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 40% (scaling) Year 6+ 75% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 60% (scaling) Year 6+ 100% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 40% (pilot) Year 5 100% (scaling) Year 6+ 100% (at scale)	The speed of reach/adoption would reflect the speed of rollout, in turn reflecting the size of the underlying investment resources and supporting elements (e.g. government policy). Assumption based on R&D and pilot phases, then a "hockey stick" rapid scale up with maximum scale achieved by 2030 (year 6).
Maximum setting consumption change (serves/person/day)	+0.19 x 0.5 = 0.095 (-50% of Rapid Review)	+0.19 (Rapid Review)	+0.38 (Rapid Review)	+0.38 (Rapid Review)	CSIRO Rapid Review (Module 1) identified 5 reviews. A minimum consumption change of +0.0 was identified across the reviews. This was revised to -50% of the average as part of the VG23005 Scenario Workshop (Module 3).
Timeline of setting consumption change (by year of first exposure)	Year 1 50% Year 2 75% Year 3+ 100%	Year 1 75% Year 2 100% Year 3+ 100%	Year 1 100% Year 2 100% Year 3+ 100%	Year 1 100% Year 2 100% Year 3+ 100%	The speed of behaviour/consumption change could reflect the intensity of the interventions, in turn reflecting scenario resources and intervention mix. 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.
Concurrent (program) cumulative effect	1.00	1.25	1.50	1.50	See ***Error! Reference source not found.*** *1 – program effects on consumption*
Sequential (time) cumulative effect	1.00	1.25	1.50	1.50	See ***Error! Reference source not found.*** *1 – program effects on consumption*

Table A.5 Benefit assumptions for the Retail setting

Modelling input name	Modelling input values				Source / comment
	Low	Mid	High	Optimal	
Target population	27.0 million (total residential population 2024) with project average annual growth of 1% to 2034	27.0 million (total residential population 2024) with project average annual growth of 1% to 2034	27.0 million (total residential population 2024) with project average annual growth of 1% to 2034	27.0 million (total residential population 2024) with project average annual growth of 1% to 2034	The entire Australian population is assumed to be exposed to the retail setting, either directly (own purchase) or indirectly (such as institutional purchases for schools, aged care, etc). Population data from ABS 3101. See *Appendix A. Baseline Projections*.
Target reach by year (by year of investment)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 20% (scaling) Year 6+ 50% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 40% (scaling) Year 6+ 75% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 10% (pilot) Year 5 60% (scaling) Year 6+ 100% (at scale)	Year 1 0% (R&D) Year 2 1% (R&D) Year 3 10% (pilot) Year 4 40% (pilot) Year 5 100% (scaling) Year 6+ 100% (at scale)	The speed of reach/adoption would reflect the speed of rollout, in turn reflecting the size of the underlying investment resources and supporting elements (e.g. government policy). Assumption based on R&D and pilot phases, then a "hockey stick" rapid scale up with maximum scale achieved by 2030 (year 6).
Maximum setting consumption change (serves/person/day)	+0.19 x 0.5 = 0.095 (Home setting)	+0.19 (Home setting)	+0.38 (Home setting)	+0.38 (Home setting)	CSIRO Rapid Review (Module 1) identified no reviews of the effectiveness of retail interventions to generate consumption change for vegetables. An assumed consumption change equivalent to the home setting was used for each scenario in the absence of retail-specific data.
Timeline of setting consumption change (by year of first exposure)	Year 1 50% Year 2 75% Year 3+ 100%	Year 1 75% Year 2 100% Year 3+ 100%	Year 1 100% Year 2 100% Year 3+ 100%	Year 1 100% Year 2 100% Year 3+ 100%	The speed of behaviour/consumption change could reflect the intensity of the interventions, in turn reflecting scenario resources and intervention mix. 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.
Concurrent (program) cumulative effect	1.00	1.25	1.50	1.50	See ***Error! Reference source not found.*** *1 – program effects on consumption*
Sequential (time) cumulative effect	1.00	1.25	1.50	1.50	See ***Error! Reference source not found.*** *1 – program effects on consumption*

Appendix 4B

Table 29 - Low investment scenario (2025-30)

Investor	Investment $ (2025 – 2030)
Hort Innovation R&D	$20 million
R&D Delivery Partners	$30 million
Program Co-ordination, Comms, M&E	$10.2 million
Government and commercial investors	$125 million
National Behaviour Change Campaign	$40 million
Total investment (2025-2030)	$225.2 million

Table 30 Low investment scenario (2031-37)

Investor	Investment $ (2031 - 2037)
Hort Innovation R&D	$20 million
R&D Delivery Partners	$30 million
Program Co-ordination, Comms, M&E	$10.2 million
Government and commercial investors	$50 million
Investment (2031-37)	$100 million

Table 31 Medium investment scenario (2025-31)

Investor	Investment $ (2025 - 2030)
Hort Innovation R&D	$69.5 million
R&D Delivery Partners	$104.75 million
Program Co-ordination, Comms, M&E	$10.2 million
Government and commercial investors	$487.5 million
National Behaviour Change Campaign	$40 million
Total investment (2025-2030)	$711.45 million

Table 32 Medium investment scenario (2031-37)

Investor	Investment $ (2031 - 2037)
Hort Innovation R&D	$20 million
R&D Delivery Partners	$30 million
Program Co-ordination, Comms, M&	$10.2 million
Government and commercial investors	$100 million
Investment (2031-37)	$150 million

Table 33 High investment scenario (2025–30)

Investor	Investment $ (2025 - 2030)
Hort Innovation R&D	$100 million
R&D Delivery Partners	$150 million
Program Co-ordination, Comms, M&E	$10.2 million
Government and commercial investors	$775 million
National Behaviour Change Campaign	$100 million
Total investment (2025–30)	$1.1352 billion

Table 34 High investment scenario (2031-37)

Investor	Investment $ (2031 - 2037)
Hort Innovation R&D	$20 million
R&D Delivery Partners	$30 million
Program Co-ordination, Comms, M&E	$10.2 million
Government and commercial investors	$150 million
Total investment (2025-37)	$200 million

Table 35 Optimal investment scenario (2025–30)

Investor	Investment $ (2025 - 2030)
Hort Innovation R&D	$75.1 million
R&D Delivery Partners	$112.5million
Retailer investment	$375 million
Program Co-ordination, Comms, M&E	$10.2 million
Government and commercial investors	$495 million
National Behaviour Change Campaign	$100 million
Total investment	$1.167 billion

Appendix 4C

Cost assumptions by scenario

Table B.1 Cost assumptions for the Low cost/impact scenario

Intervention year	1	2	3	4	5	6	7	8	9+
Year ending 30 June	2025	2026	2027	2028	2029	2030	2031	2032	2033+
Program delivery costs (Frontier Fund) $m	15.8	9.3	7.5	7.5	5.0	5.0	13.8	11.3	6.3
Hort Innovation Investment (40%)	6.3	3.7	3.0	3.0	2.0	2.0	5.5	4.5	2.5
Delivery Partner Co-investment (60%)	9.5	5.6	4.5	4.5	3.0	3.0	8.3	6.8	3.8
Program management costs (VG Fund) $m	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Other commercial co-investment $m	0.0	0.0	37.5	37.5	25.0	25.0	13.8	11.3	6.3
National Behaviour Change Campaign $m	6.0	6.0	2.0	2.0	2.0	2.0	0.0	0.0	0.0
TOTAL SCENARIO COST $m	**23.5**	**17.0**	**48.7**	**48.7**	**33.7**	**33.7**	**29.2**	**24.2**	**14.2**

Table B.1 Cost assumptions for the Mid cost/impact scenario

Intervention year	1	2	3	4	5	6	7	8	9+
Year ending 30 June	2025	2026	2027	2028	2029	2030	2031	2032	2033+
Program delivery costs (Frontier Fund) $m	36.0	40.3	27.5	30.0	18.8	21.3	13.8	11.3	6.3
Hort Innovation Investment (40%)	14.4	16.1	11.0	12.0	7.5	8.5	5.5	4.5	2.5
Delivery Partner Co-investment (60%)	21.6	24.2	16.5	18.0	11.3	12.8	8.3	6.8	3.8
Program management costs (VG Fund) $m	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Other commercial co-investment $m	0.0	0.0	137.5	150.0	93.8	106.3	27.5	22.5	12.5
National Behaviour Change Campaign $m	12.0	12.0	4.0	4.0	4.0	4.0	0.0	0.0	0.0
TOTAL SCENARIO COST $m	**49.7**	**54.0**	**170.7**	**185.7**	**118.2**	**133.2**	**43.0**	**35.5**	**20.5**

Table B.1 Cost assumptions for the High cost/impact scenario

Intervention year	1	2	3	4	5	6	7	8	9+
Year ending 30 June	2025	2026	2027	2028	2029	2030	2031	2032	2033+
Program delivery costs (Frontier Fund) $m	47.5	47.5	42.5	40.0	37.5	35.0	13.8	11.3	6.3
Hort Innovation Investment (40%)	19.0	19.0	17.0	16.0	15.0	14.0	5.5	4.5	2.5
Delivery Partner Co-investment (60%)	28.5	28.5	25.5	24.0	22.5	21.0	8.3	6.8	3.8

Program management costs (VG Fund) $m	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Other commercial co-investment $m	0.0	0.0	212.5	200.0	187.5	175.0	41.3	33.8	18.8
National Behaviour Change Campaign $m	24.0	24.0	14.0	14.0	12.0	12.0	0.0	0.0	0.0
TOTAL SCENARIO COST $m	**73.2**	**73.2**	**270.7**	**255.7**	**238.7**	**223.7**	**56.7**	**46.7**	**26.7**

Table B.1 Cost assumptions for the High cost/impact scenario

Intervention year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9+**
Year ending 30 June	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033+**
Program delivery costs (Frontier Fund) $m	37.5	35.3	30.0	30.0	26.3	28.8	13.8	11.3	6.3
Hort Innovation Investment (40%)	15.0	14.1	12.0	12.0	10.5	11.5	5.5	4.5	2.5
Delivery Partner Co-investment (60%)	22.5	21.2	18.0	18.0	15.8	17.3	8.3	6.8	3.8
Program management costs (VG Fund) $m	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Other commercial co-investment $m	150.0	125.0	175.0	170.0	150.0	100.0	27.5	22.5	12.5
National Behaviour Change Campaign $m	12.0	12.0	4.0	4.0	4.0	4.0	0.0	0.0	0.0
TOTAL SCENARIO COST $m	**201.2**	**174.0**	**210.7**	**205.7**	**182.0**	**134.5**	**43.0**	**35.5**	**20.5**