2024

FINAL REPORT

Horticulture Sector Action Plan to Reduce Food Waste

ENDFOODWASTE AUSTRALIA

Australian Government
Department of Industry, Science and Resources

AusIndustry
Cooperative Research Centres Program

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END FOOD WASTE AUSTRALIA REPORT APPROVAL

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Panel Review Statement

End Food Waste Australia recognises the value of knowledge exchange and the importance of objective peer review. It is committed to encouraging and supporting its research teams in this regard. The author(s) confirm(s) that this document has been reviewed and approved by the Project Leader and Industry Partner.

This project has also been evaluated by the End Food Waste Australia publication review panel. These reviewers evaluated its:

- Methodology articulated clearly.
- Positioning of findings within the current literature
- Acknowledged compliance with food safety standards
- Conclusions against results
- Relevant human and/or animal ethic approvals obtained.

End Food Waste Cooperative Research Centre is funded through the Australian Government's CRC Program administered by the Department of Science, Industry and Resources.

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Industry Partner Foreword

Australia's 7.6 million tonnes of annual food waste is a challenge too big to solve alone. This plan is a first of its kind in Australia looking at collaborative and impactful solutions across the entire horticulture food supply chain to tackle food waste.

Reducing fresh produce waste is critical to reaching Australia's goal of halving food waste by 2030 and will have positive impacts for everyone, including growers, food insecure Australians, and the food industry, as well as on the economy and the environment.

I am incredibly proud to endorse the Horticulture Sector Food Waste Action Plan, developed following a year-long research and extensive stakeholder engagement process. This plan provides invaluable insights into the root causes of food waste hotspots and, importantly, outlines the solutions and next steps to reduce this waste. I encourage everyone to get involved.

-Dr Steven Lapidge, CEO End Food Waste Australia.

The Queensland Government's Organics Action Plan 2023-2032 provides the roadmap for how Queensland plans to avoid generating organic waste and improve the management of material that can't be avoided. Horticulture is Queensland's second largest primary industry growing approximately one- third of the nation's produce. End Food Waste Australia has developed a food waste action plan for the horticulture sector with support from the Queensland Government's Recycling and Jobs Fund.

-Queensland Department of Environment and Science

Here at Hort Innovation we recognise reduction of food waste in our 2023/2024 Australian-grown Horticulture Sustainability Framework. We are working with our industries to increase the proportion of produce that meets first grade standards and increasing utilisation of lower grade produce to reduce food waste across the production system. Through the opportunity to be actively involved in the co-design of the Horticulture Sector Food Waste Action Plan we have been able to provide input on industry– wide implementation priorities to increase profitability and reduce environmental impacts.

-Kathryn Young, Head of Sustainability R&D, Horticulture Innovation Australia

The National Farmers Federation Horticulture Council is the is the preeminent forum for deliberating and forming policy and advocating on behalf of our national horticulture industry. As a body comprising 21 national commodity and state peak horticulture bodies, we recognise sustainability is integral to productive and profitable farm businesses. Reducing food waste on farm, and across the supply chain, will have benefits for profitability and the planet. This Plan provides clear direction and rationale for our industry to take action to reduce food waste, and work with others across the supply chain to repurpose excess crops and advocate for a supportive enabling policy environment.

-Jolyon Burnett, Chair, National Farmers Federation Hort Council

Wholesale markets are a vital component of the horticulture supply chain. Understanding how fresh fruit and vegetables gets to the consumer helps to ensure the actions we all take along the supply chain to reduce food waste has the impact we need. I have been pleased to be part of this collaborative process to reduce food waste across our sector.

-David Whichello former COO, Melbourne Market Authority

As a dedicated grower, witnessing the wastage of meticulously cultivated food pains me. This waste can stem from various factors such as unpredictable weather events, stringent produce specifications, fluctuating market demand, or challenges in transporting the crop to market. Collaborating on the development of a sector action plan alongside university researchers and representatives spanning the entire supply chain has provided a platform for me to voice my concerns and contribute suggestions to enhance the efficiency of bringing more of my crop to consumers.

-Ros Rackemann, Watermelon, Pumpkin Grower North Burnett Region (QLD)

The Australian banana industry has been privileged to be part of the overall investigations into reducing food waste in Horticulture. The 'deep dive' undertaken with the researchers highlights clear actions to inform and empower our producers to reduce banana food waste and increase their profitability.

-Rosie Godwin PhD, R&D Manager | Australian Banana Growers' Council

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Industry Partner Foreword (cont.)

We know that banana growers and other industry participants do not intend to waste their valued and carefully grown, harvested, packed, shipped, ripened, stored, and displayed produce. Yet we also must recognise that fruit and vegetables are the most wasted food across the supply chain, and that bananas are in the topmost wasted fruits.

Australia has committed to halving food waste by 2030, in line with the United Nations Sustainable Development Goal 12.3. The Australian Banana Growers' Council is proud to be at the forefront of the horticulture industry in finding solutions to reduce banana food waste. By reducing food waste, we have a triple win – improving our industry profitability, reducing environmental impact, and assisting in food insecurity for those in need.

Australian Banana growers have always embraced ways to improve our industry and this plan to reduce food waste is no exception. I encourage anyone who is a part of the banana supply chain to read this plan and get involved in any way they can because we all have a part to play in making our industry more sustainable.

- Leon Collins, Chairman, Australian Banana Growers' Council

Melons Australia is committed to supporting our industry's involvement in Australia achieving its goal to halve food waste by 2030 in accordance with the United Nations Sustainable Development goal 12.3. This comes with a recognition that this requires the commitment of all commodities and all supply chain actors. We are very pleased to be at the forefront of the horticulture industry, taking tangible steps to contribute to the national target and we are proud to have played an important role in the development of the Australian Melon Industry food waste action plan.

Melons are grown in all states on mainland Australia as well as the Northern Territory and the industry includes a large and diverse range of stakeholders from seed producers to growers, pickers, packers, transporters, marketers, and retailers, all of whom have a role to play in this action plan. Growing melons for food requires financial, human, and environmental resources that do not realise their optimum return if the food is not consumed, so it's not just the food that is wasted.

We acknowledge that by reducing food waste we create opportunities to improve grower profitability, reduce the environmental footprint of food waste and assist those Australians experiencing food insecurity. We encourage everyone to familiarise themselves with this plan, support future work programs and to take action however and whenever they can.

- Jonathan Davey, Executive Officer, Melons Australia

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1. Introduction

Food waste is a critical local and global issue. Reducing food waste and its associated economic, social, and environmental effects brings substantial benefits to people, communities and businesses. The National Food Waste Strategy Feasibility Study (FIAL, 2021) documents a food waste baseline and identifies hotspots along the supply chain for 18 commodities in Australia. Food Innovation Australia Limited (FIAL) has estimated that the current annual total economic loss impact could be around $36.6 billion from an amount of about 7.6 M tonnes (million tonnes) of food waste within the food supply chain in Australia (FIAL, 2021b). Many of these commodities belong to the horticulture sector.

Although the horticulture sector is the third highest (17%) in value among agricultural industries (DAFF, 2023), it is accountable for about 50% of the total food waste in Australia (FIAL, 2021). At a national level, annually, Australia loses about 24% of fruits and vegetables at the production stage, 11% at processing/packing stages, and 11% after processing or packaging until retail (FIAL., 2021). For some commodities (e.g., banana, melon), waste or loss is much higher than that of these average figures. A recent ABARE's survey suggested that on average, melon farms have crop wastage of about 20.19% per farm and banana farms have crop wastage of about 28.6% per farm in Australia. In addition, one-third of the production was forcedly discarded from the marketing system. For example, post-harvest loss in the melon industry was very high level, sometimes going up to 48% (Ambiel et al., 2019). Australian horticulture supply chain management systems have not been able to significantly prevent food waste (Messner et al., 2022), which is at a very high level compared with other agricultural products (McKenzie et al. 2017).

Though recent research has highlighted the above issues of horticultural waste (Australian Government, 2017; FIAL, 2019: FIAL, 2021; SFWA, 2023), these studies, however, did not provide clear recommendations to address food loss and waste in the sector. This project addressed this gap by developing a Horticulture Sector Action Plan (Hort SAP) for Food Waste Reduction along with two commodity specific food waste reduction action plans for banana and melon industries.

Sector action plans (SAPs) provide a systems-based approach to reducing food waste and constitute a useful planning and management tool for supply chain partners and collaborators in the targeted sector. Each SAP is co-designed with key stakeholders—those who are most able to directly control or influence root causes of food waste hotspots and to take actions to reduce or eliminate food waste in the value chain. Initiatives in each SAP are fit-for-purpose, balancing targeted interventions between five different pillars (see Figure 1) and reflecting current knowledge with options for refocusing over time.

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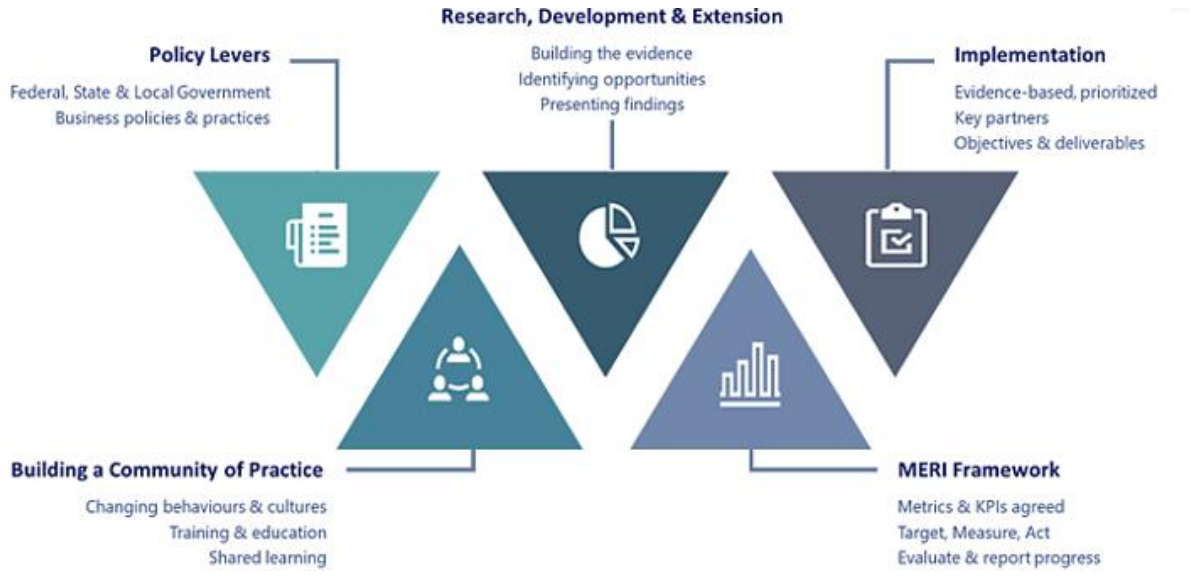

Figure 1: The five pillars supporting the delivery of sector action plans

(Source: Supplied by EFWA, 2023)

This project aimed to develop a Horticulture Sector Action Plan for Food Waste Reduction (Hort SAP). In addition, this project focused on commodity specific action plans for food reduction, for banana and melon. Specifically, the following reports were generated:

1. Horticulture Sector Action Plan Technical Report
2. Horticulture Sector Action Plan Summary
3. Banana Industry Sector Action Plan Technical Report
4. Banana Industry Sector Action Plan Summary
5. Melon Industry Sector Action Plan Technical Report
6. Melon Industry Sector Action Plan Summary

The purpose of this report is to summarise the overarching research project findings.

Commodity specific action plans were developed using the Waste and Resources Action Program's (WRAP) whole chain food waste reduction plan toolkit (WRAP, 2020a, 2020b). Initial research focused on identifying waste hotspots, followed by root cause analysis. Using the food recovery hierarchy, the project identified and prioritised a range of practical solutions and action plans through co-designed workshops with targeted stakeholders. The scope of this study includes:

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- Hotspots of waste in the horticulture sector from primary production to the retailing stage (before consumption). The project does not deal with consumption /household waste.
- For the purposes of this study, the focus is on fruits and vegetables, which are highly perishable and edible horticultural commodities.
- Two separate commodity specific action plans focused only on banana and melon were developed and the findings may not be transferable to the other commodities.
- Utilisation of currently available data and information on food waste.
- Hotspots and root causes of waste for the horticulture sector and for the banana and melon industry.
- Reducing horticultural waste by using a food recovery hierarchy.
- Prioritising solutions (i.e., proposing action plans).
- Proposing a monitoring and evaluation framework for the action plans.

Horticulture food waste is often referred to as edible plants produced for human consumption, but not consumed by people. This study reviewed the volume and value of waste based on the available data and literature. The study did not include (excluded):

- Food waste at the consumption or household stage.
- Waste of exported food (food that was produced in Australia but wasted outside Australia).
- Horticultural waste that was never intended for human consumption.
- Quantification of volume and value of food waste through primary data collection or experiments.

Please note *food loss* is defined as the decrease in quality/quantity of food as a result of the decisions or actions in the food supply chain. The *food waste* is defined as the decrease in quality/quantity of food as a result of the decisions or actions by retailers, food service providers and consumers (Beausang et al., 2017; Gooch & Felfel, 2020; Yahia et al., 2019). In this report, the term 'food waste' refers to both food loss and waste.

2. Methodology

The study employs the Review-Plan-Do SAP methodology (FIAL, 2019) to develop the Horticulture Sector Action Plan for Food Waste Reduction. This method has been endorsed by the Australian National Food Waste Strategy Steering Committee (FIAL, 2019). It first focuses on identifying waste hotspots and investigating the root causes of the waste. Using the food recovery hierarchy, it then identifies and prioritises a range of practical solutions through co-designed workshops (Figure 6) to facilitate industry adoption.

This study used a sequential mixed methodology to conduct the research and to triangulate the key findings. Actions were then prepared based on the key findings. The study team carried out the following procedure:

1. Conduct the literature review, summarise key findings and identify key inquiries for stakeholder discussion.
2. Carry out stakeholder interviews to discuss key inquiries of the study with each member of the Hort Sector Action Plan Advisory Committee and summarise key findings.
3. Discuss key findings from the interviews in Workshops 1 and 2 and further identify and validate hotspots, root causes and solutions.

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4. Refine and shortlist the solutions in Workshop 3 and prepare strategic actions to reduce food waste.

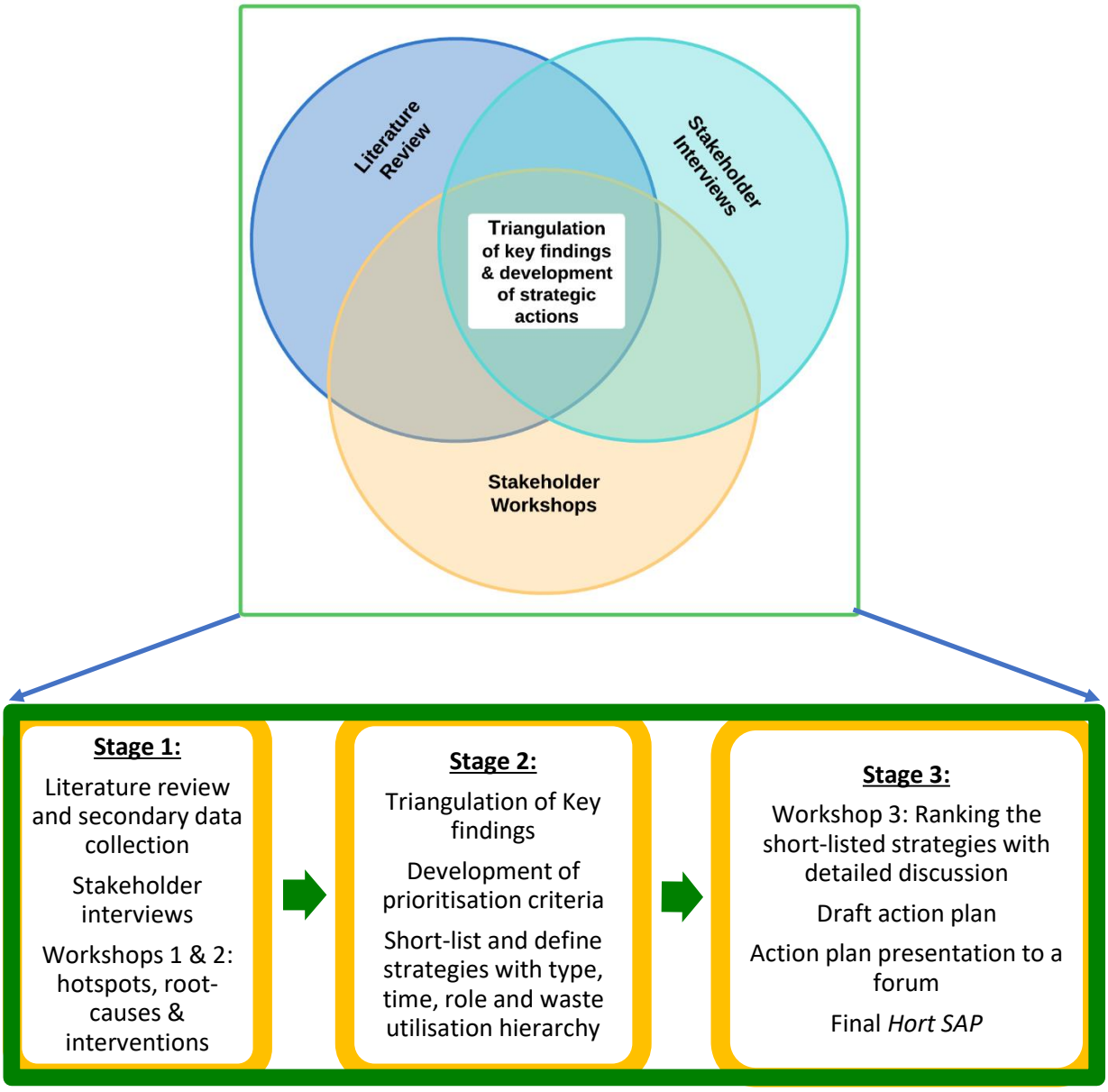

Figure 2: Research design for Hort SAP

We have identified common areas of strategic actions consistent with the National Food Waste Strategy (2017) framework adopted by the Australian Government. A food waste prevention and management hierarchy (Figure 3) was applied to prioritise all actions proposed in this report. It should be noted that only actions within the green sections of the hierarchy, "prevention" and "repurposed", count towards Australia's goal of halving food waste by 2030 (Australian Government, 2017). These actions retain

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the highest value of the food produced and have the greatest impact in reducing the environmental, social, and financial cost of food waste. These criteria were then used to prioritise short-listed solutions into actions, alongside expert judgement, and industry consultation.

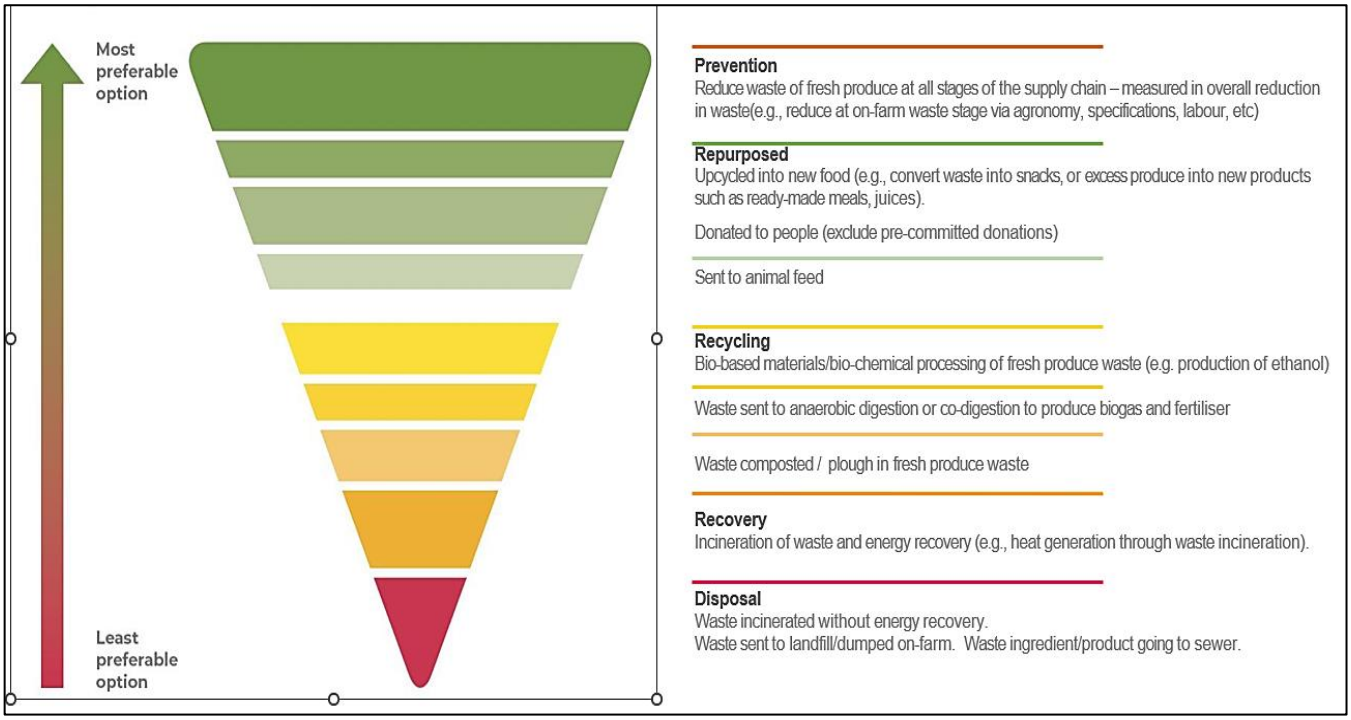

Figure 3: Horticulture specific food recovery hierarchy

(Source: SFWA, 2023)

In addition, the WRAP UK whole chain food waste reduction plan toolkit (WCP) was used for the development of the action plans for the banana and melon commodities. In both the commodity specific action plans, three essential components of WCP toolkits were used which are: where is the waste occurring (Hot spots); why is the waste occurring (root causes); and what are the possible solutions (i.e., actions) to prevent the waste from occurring (strategies). Similar methods (Figure 2) were utilized for the commodity specific action plans for banana and melon industries except only two workshops were undertaken, one for identifying and validating hotspots and root causes, and another for solution identification and prioritisation, instead of the three workshops used for the overarching Hort SAP.

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3. Results & Discussion

FIAL (2021) study found that food waste across the horticulture sector, particularly fruit and vegetable supply and consumption chain was highest among certain food sub-sectors. It is estimated that the fruit and vegetable (root, non-root and brassicas) sub-sectors have generated 908,403 tonnes and 409,744 tonnes of food waste in the primary production and processing stages, respectively, in 2021. FIAL (2021) suggests seven main points of food waste for these sub-sectors across the supply chain, including primary, processing, distribution, retail, household, hospitality and institutional. As presented in Table 3, the three main food waste hotspots of this chain are primary, household and hospitality (household, and hospitality, however, are beyond the scope of the present study). This finding of hotspots aligns with that of similar studies on horticultural food waste in Australia, where primary production has been identified as a major waste point in the supply chain (SFWA, 2022).

Table 1 Estimated food waste of fruit and vegetable in Australia in 2021 across the supply chain.

Supply chain stage	Amount of waste (tonnes)	Percentage of waste in the chain
Primary	908,403	23.7
Processing	409,744	10.7
Distribution	208,380	5.4
Retail	217,433	5.7
Household	1,271,850	33.2
Hospitality	757,992	19.8
Institutional	57,353	1.5
Total	3,831,155	100

Source: Calculated by the authors based on FIAL (2021)

3.1 Horticultural Food Waste: Hotspots and Root Causes

Fresh horticultural products are living organisms whose quality and shelf life are affected by diverse factors that contribute to food waste (Yahia et al., 2019). Identifying and tracking associated root causes are of critical importance for developing strategies for preventing and managing food waste. A triangulation of the findings gathered from the literature review, interviews and workshops were applied to validate and confirm information related to hotspots and root causes of horticultural waste in Australia. Key findings from the triangulation are summarised and presented in Table 2.

Table 2 Triangulation of the key findings: Hotspots and root causes across the supply chain

Root causes	Primary production	Post-harvest grading and packaging	Transport	Warehouse and distribution centre	Retail
RC 1 - Food waste measuring and monitoring systems: A lack of knowledge, business priority and data has meant that the Horticulture Industry has only implemented ad hoc food waste reduction initiatives in periods when food waste is increasing significantly	✓	✓		✓	✓

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Root causes	Primary production	Post-harvest grading and packaging	Transport	Warehouse and distribution centre	Retail
RC 2- Agronomy and environment: Pests and diseases, unsuccessful varieties, poor water and fertiliser regimes, weather damage, such as sunburn/frostbite/wind or rain or hail damage.	✓	✓			
RC 3 - Cycle of over production: Speculative growing to manage viability risk; lack of adequate forecasting and market understanding; weather and climatic implications, such as quick flushes; and supply and demand mismatch.	✓			✓	✓
RC 4 -Workforce availability and skills: Lack of skilled labour in the harvesting season, and lack of attractiveness and minimal employee career pathways, and limited vertical integration in the supply chain.	✓	✓	✓	✓	✓
RC 5 - Product standards and specifications: Cosmetic specifications, contract farming, price variation and change of consumer preferences.		✓			✓
RC 6 - Redistribution of food waste: Lack of redistribution network and facilities, and lack of social acceptance.	✓	✓			✓
RC 7 – Technology and infrastructure: Lack of storing and cooling facilities, and lack of innovation and use of technologies.	✓	✓	✓	✓	✓
RC 8- Value adding opportunities and collaboration: Lack of vertical and horizontal collaboration to develop commercially viable value-added facilities.	✓	✓	✓		
RC 9 - Policy and regulation: Red tape, interjurisdictional inconsistency, and absence of regulation or financial incentives that can prevent food waste.	✓		✓		✓

3.2 Actions for Waste Prevention and Reduction in Horticulture Sector

As outlined above, we have examined a range of root causes and developed key actions in response. The actions identified were informed by reviewing the existing research, literature, stakeholder interviews and stakeholder Workshops 1, 2 and 3, and we have focused on key game changing actions rather than addressing every issue. In addition, key actions were further validated through stakeholder forums and one-to-one discussions with targeted stakeholders. Table 3 outlines the key actions, and the root causes they respond to. It should be noted that actions can cover multiple root causes and root causes can require multiple sub-actions. The actions are categorized into three groups: enabling (E) (make it easier to reduce food waste), preventing (P) (stop food waste occurring in the first place) and repurposing (R) (from food waste to resource).

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Table 3 Action and root cause mapping

Categories	Actions	Addressing Root Causes
Enabling	E1. Identify root causes of food waste and develop sector action plans for key horticultural commodities.	RC 1, RC 2 and RC 3
Enabling	E2. Establish mechanisms for data collection, monitoring, measuring, and reporting to generate evidence about food waste in the horticulture industry.	RC 1 and RC 9
Enabling	E3. Institute an effective policy and regulatory environment for food waste minimisation across the horticulture sector.	RC 9
Enabling	E4. Accelerate and incubate innovation and technology solutions in the horticultural industry for food waste minimisation.	RC 2 and RC 7
Preventing	P1. Apply mechanisms for managing overproduction and balancing the demand and supply of horticultural products.	RC 2 and RC 3
Preventing	P2. Address labour and skill shortages across the horticultural supply chain for different commodities cycles of production and distribution.	RC 3 and RC 4
Preventing	P3. Reduce the impact of product specifications on food waste.	RC 5
Repurposing	R1. Explore ways to value add to surplus or waste produce.	RC 3 and RC 8
Repurposing	R2. Implement effective mechanisms for food donation.	RC 6 and RC 9

Four priority criteria (volume, financial feasibility, technical feasibility, and best and highest use principle) were used to prioritise the actions. The actions also follow a ReFed continuum of prevention, and repurpose (i.e., rescue and recycle or value add) (ReFED, 2023). Finally, nine strategic areas of action were identified with key objectives, how to achieve the objectives, the desired outcomes, and potential indicators for impacts. The actions suggested are also derived from enablers of change. These include planning, policy and regulatory levers, capacity building and training, sharing information, research and innovation, awareness and behaviour change, collaboration and evaluation and use of technologies.

It is anticipated that the interventions will yield outcomes at different paces. For this reason, the actions are allocated a timeframe for realisation. These timeframes are defined as:

- Short term (ST): 2024-2026
- Medium term (MT): 2026-2027
- Long term (LT): 2027-2030

The roadmap presented on the next page shows the key actions against the indicated timeframes.

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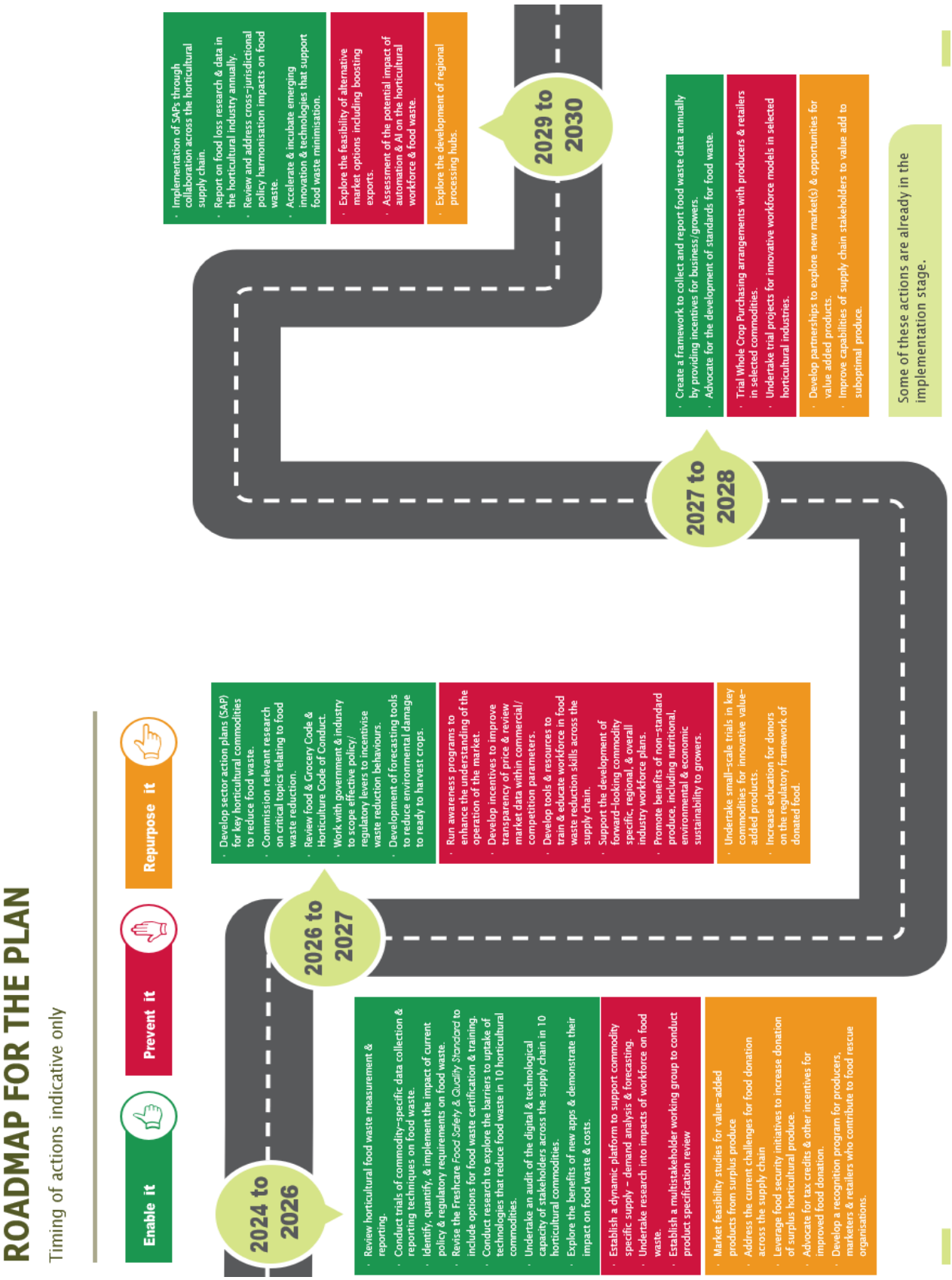

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3.3 Food Waste Hotspots in Banana industry

The National Food Waste Baseline (Arcadis, 2019) provided detailed data describing food waste across the fruit and vegetable sector, including banana food waste, which suggested that national on-farm loss of bananas in 2016/17 was more than 40,000 tonnes, which is significantly higher when compared to other commodities considered in the fruit, nuts and wine grapes category. In 2022, ABARES (Downham, 2022) conducted a horticulture survey of 2,692 horticulture farms across Australia. They found the average percentage of crop waste for bananas in Australia was 29% per farm in 2021-22—19.3% pre-harvest and 9.0% during or after harvest, while only 0.2% were recovered for an alternative use. Hotspots for pre-harvest food waste are on-farm, and post-harvest hotspots include transport and cold chains, wholesale or distribution centres, retailers and consumers (consumer food waste is out of the scope of this project). These banana waste figures and hotspots were discussed during the stakeholder interviews and in Workshop 1, and most of the stakeholders agreed with a range between 15% to 19% for on-farm banana food waste.

3.4 Root Causes for Food Waste in the Banana Industry

Root causes are a fundamental consideration behind food waste (Møller et al., 2014; Moragues-Faus et al., 2017), and are often location-specific (Van Berkumet al., 2018). The Canadian Commission for Environmental Cooperation (CEC, 2021) suggested that there are two layers to identifying the root causes of food waste: (1) an immediate/proximate reason why food is wasted or lost, namely the cause and (2) the underlying factor that plays a role in creating that reason, namely driver or root causes. By synthesising the research and the outcomes of stakeholder engagement three main reasons (apparent causes) for food waste have been identified:

1. The fruit is physically damaged or not within the produce specification, that is, the fruit does not meet the criteria for sale.
2. Crop damage, that is, the crop—fruit and/or plants—are rendered unusable, usually in the field.
3. Fruit is unviable and does not warrant progressing further in the supply chain, often the result of an oversupply.

These can be traced back to six root causes:

1. Agronomy
2. Climate and weather events
3. Packaging, transport and warehousing
4. Commercial and legal
5. Management and planning
6. Market conditions

This project did not address waste at the consumer level, hence, the associated causes and root causes of food waste at that point in the supply chain had not been included.

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3.5 Actions for Waste Prevention and Reduction in the Banana Industry

The study identified various actions to prevent and reduce food waste in the banana supply chain based on the key findings from literature review, stakeholder interviews and stakeholder workshops. The action plan was subsequently validated through consultation with the Banana Growers Association and other stakeholders. Through this process, 11 actions were presented in the final solution workshops, where an in-depth discussion for finalising the actions was undertaken, and four criteria were used to validate and prioritise them (volume, financial feasibility, technical feasibility, and best and highest use principle). Based on this discussion, the research team identified nine strategic areas of action, including four prevention strategies, two repurposing strategies and three enabling strategies. All nine strategies and corresponding actions are presented in this section with brief descriptions. Figure 4 gives a short description of the strategies and their position in the food waste hierarchy.

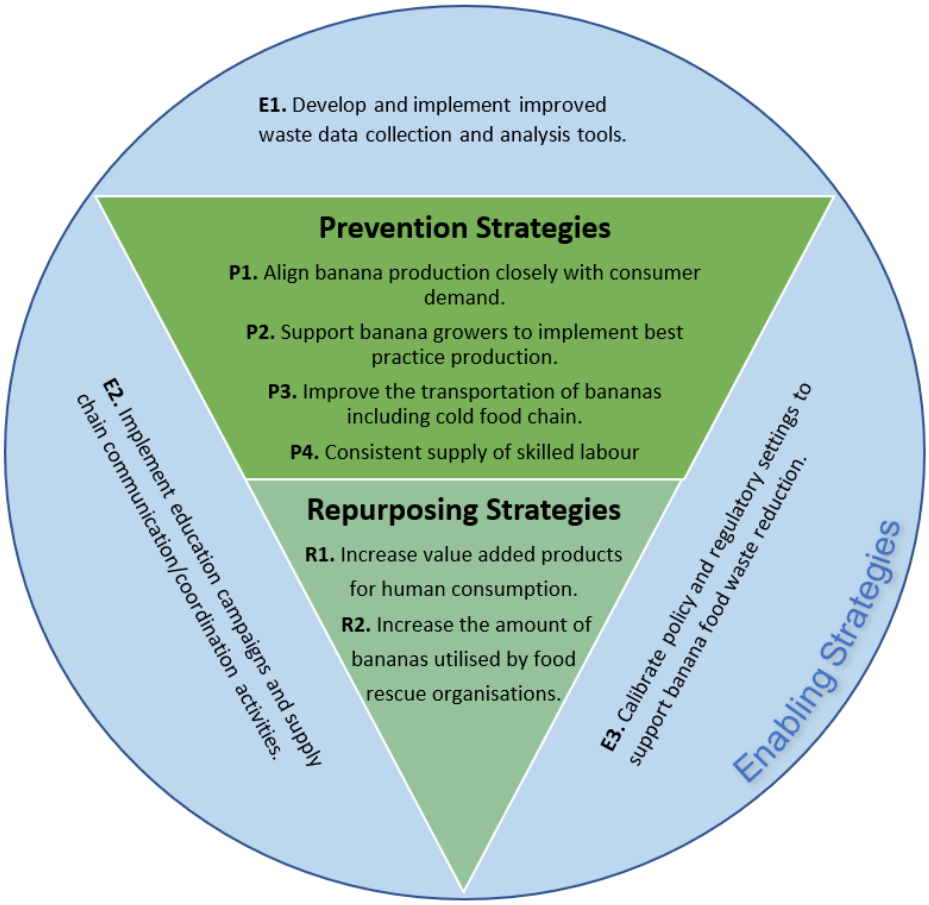

Figure 4: Food waste prevention and reduction strategies and actions for Banana Industry

All the strategies in the Banana industry action plan consist of multiple actions that will deliver measurable outcomes in different time horizons. The following roadmap (see next page) highlights the potential journey for the banana industry to reach the 2030 target of halving Australia's horticulture food waste. Ongoing communication and support from all banana supply chain organisations, the food rescue sector, not-for-profit organisations (e.g., Stop Food Waste Australia) and all tiers of government can ensure effective delivery of solutions to meet the 2030 target.

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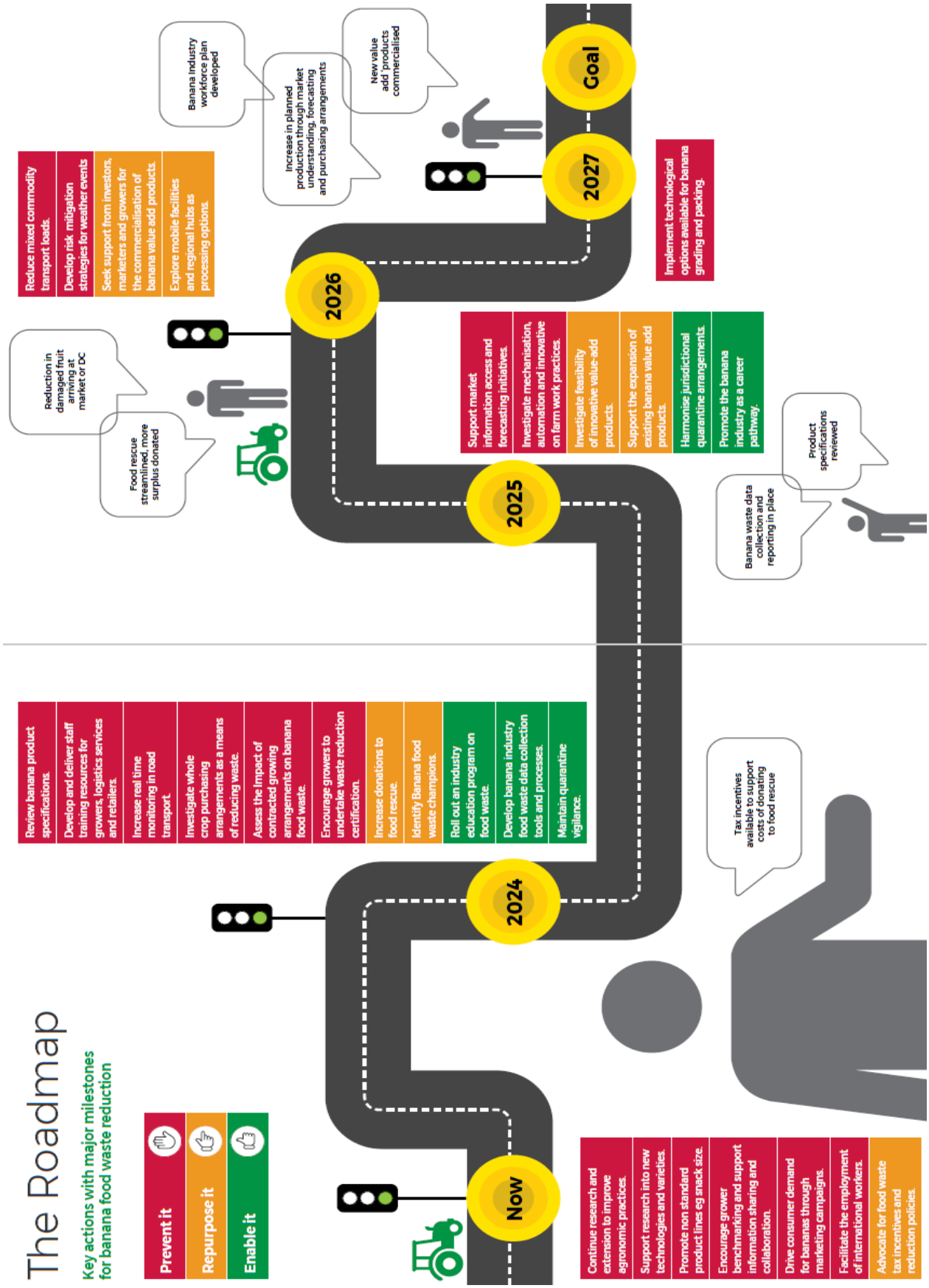

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3.6 Food Waste Hotspots in Melon Industry

The average percentage of crop loss/waste for melons in Australia was 20.19% per farm in 2021-22, which includes 14.41% from the pre-harvesting stage and 5.42% during- and post-harvest losses (Downham, 2022). In the state of Queensland, there was a 29.42% per farm total loss, made up of 21.98% from pre-harvest and 7.45% during- and post-harvest losses (Downham, 2022).

The quantity of melon loss and wastage reported by Adell et al. (2019) indicates that the largest single hotspot is in the field or preharvest. The remaining supply chain stages collectively contribute an equivalent amount to the total pre-retail melon food waste. Engagement with melon supply chain stakeholders regarding food waste hotspots confirmed the significant levels of on-farm waste. Wastage in transport and warehousing was considered minimal.

3.7 Root causes for Food Waste in Melon Industry

The three apparent causes of food waste in the melon industry are similar to the banana industry, which are:

1. Fruit is physically damaged or does not meet produce specifications.
2. Fruit is unviable and does not warrant progressing further in the supply chain, often the result of an oversupply.
3. Unusable fruits, that is, the fruits are rendered unusable, usually in retail.

These apparent causes can be traced back to six root causes:

1. Agronomy and weather
2. Farm management practices
3. Labour issues
4. Storage and transport
5. Supply chain issues
6. Retail fruit handling management/operational issues

As mentioned earlier, this project does not address waste at the consumer level, so the associated causes and root causes of food waste at that point in the supply chain have not been included.

3.5 Actions for Waste Prevention and Reduction in Melon Industry

The study identified various actions to prevent and reduce food waste in the melon supply chain by reviewing existing practices and through recommendations from stakeholders in the interviews and in Workshops 1 and 2. The project team short-listed 11 actions and presented them for further discussion between the stakeholders in the final workshops. Based on the discussion in the final workshop the research team developed 10 strategic areas of action, including three enabling strategies, five prevention strategies and two repurposing strategies, as shown in Figure 5. The 10 strategies and corresponding actions are outlined individually in detail which can be found in the Melon Industry SAP technical report.

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Figure 5: Food waste prevention and reduction strategies and actions for Melon Industry

All the strategies in the melon industry action plan have multiple actions that will deliver measurable outcomes in different time horizons. A detailed list of the actions associated with each strategy can be found in the Melon SAP technical report. The following roadmap (see next page) highlights the potential journey for the melon industry to reach the 2030 target of halving Australia's horticulture food waste.

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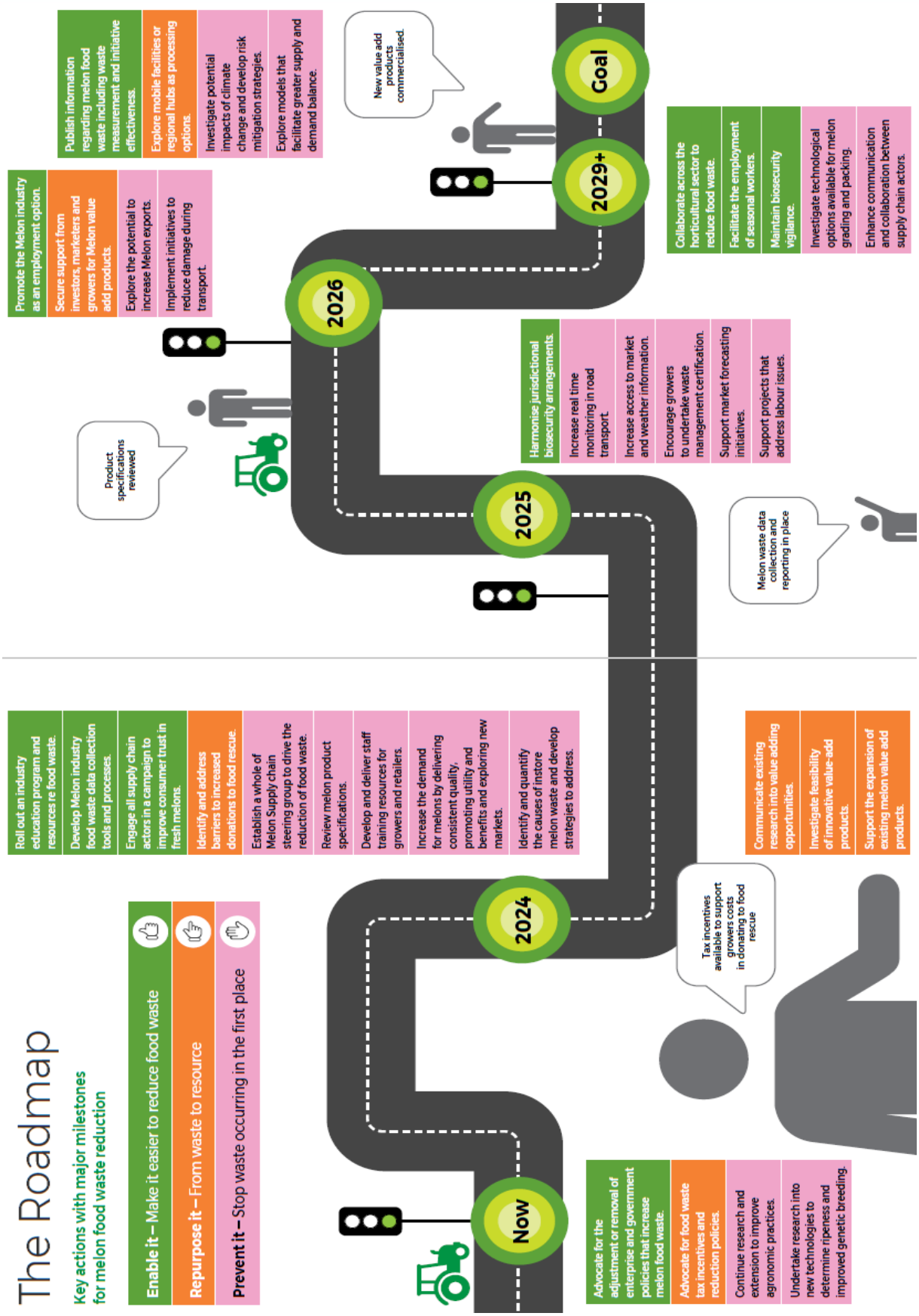

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4. Impact and Ongoing Monitoring

Achieving food waste outcomes and impact is a complex process, which involves the participation of diverse stakeholders across varied production and distribution cycles. It is important to develop a monitoring, evaluation, reporting and improvement (MERI) plan to demonstrate impact, support learning and improvement, and meet accountability requirements. The MERI plan will incorporate the following:

- *Monitoring:* Continuous and systematic observations of how the programs are being implemented, the effect of strategies used for addressing waste, and indicators of outcomes.
- *Evaluation and reporting:* Evidence-based assessment of the impact of the programs, including social, economic, environmental, and cultural impacts, which focuses on factors such as effectiveness, efficiency, appropriateness and impact.
- *Learning (i.e., for improvement):* Creation and sharing of knowledge, generation of insights and information, and program delivery about lessons learned to inform future practice, policy and program development.

While a MERI Plan is not presented in this report, a full monitoring and evaluation plan can be developed and implemented at the outset of the implementation of the overall food waste action plan.

4.1 Potential Impacts of the Horticulture SAP

Horticulture SAP provides an overall national framework to assist actors across the horticulture supply chain to prevent or reduce food waste of fresh produce. The impacts of this project are realised through the implementation of the *Horticulture Sector Action Plan for Food Waste Reduction (Hort SAP)*. Potential long-term impacts of the present study are:

1. *Food waste reduced:* The National Food Waste Baseline suggests that around 2.27 M tonnes of food never leaves the farm, which accounts for 31% of total food loss (FIAL, 2021; ARCADIS, 2019). About half (i.e., 44%) of this on-farm loss is from fruit and vegetables (FIAL, 2021; ARCADIS, 2019). The interventions and actions suggested in this study would deliver a 50% reduction in horticulture waste by 2030 as this goal was set by the Australian Government (Australian Government 2017; FIAL, 2021). This is an aspirational goal for the horticultural sector given the national policy targets and the overall quantum of food waste in the horticultural sector.
2. *Industry profitability:* A reduction in disposal costs and/or increase in the proportion of crops to market will contribute to higher profitability.
3. *Food redistribution:* More fruits and vegetables will be rescued through redistribution.
4. *Greenhouse gas emission savings:* There will be reduced greenhouse gas emissions due to reduced use of inputs, such as energy, fertiliser and pesticides, and reduced organics disposed in landfills.
5. *Creating a circular economy:* Opportunities for converting by-products and secondary streams into new products will be identified and validated, enabling circular economy jobs relating to sorting, processing, stabilisation, transportation and preparation for market.
6. *Training industry people:* Industry people will be aware and willing to share knowledge with their community of practice.

The indicators of outcomes associated with each of the strategies and sub strategies are presented in the horticulture sector action plan for food waste reduction technical report which can be accessed through on End Food Waste Australia resource hub (https://endfoodwaste.com.au/resource-hub/).

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4.2 Indicators of Outcome and Impact for the Horticulture industry sector action plan

Indicators are measures that show if the outcome and impact are being achieved. It is a metric that provides information to monitor performance and measure achievement against outcomes and the impact of the intended action or activity. The following table indicates the indicators associated with the horticulture industry sector action plan for reducing food waste.

Table 4 Indicators of outcomes and impacts for Horticulture industry sector action plan for food waste reduction

Strategic actions	Indicators
E1 Identify root causes of food waste and develop sector action plans for key horticultural commodities.	• Quality information about root causes of food waste developed targeted to relevant horticultural commodities. • A number of commodities for which root cause analysis is conducted. • Sector action plans (SAPs) are developed to reflect the value of food waste reduction in tonnes, dollars or GHG. • A number of actions are initiated across horticultural commodities. • Level of buy-in and participation in SAP. • Implementation across the supply chain. • Assessment of outcomes from actions initiated towards food waste reduction in key sectors. • A number of collaborations across the supply chain. • Qualitative assessment of the progress of SAPs. • Broader measures such as participation in the Australian Food Pact. • A number of dissemination activities that link to the best practice for food waste reduction. • Links with science agencies for information. • Filtration and uptake levels of knowledge.
E2 Establish mechanisms for data collection, monitoring, measuring, and reporting to generate evidence about food waste in the horticulture industry.	• A literature review is conducted. • Analysis of the benefits of different methodologies identified. • Data collection gaps and challenges are determined. • A working party is established to collaborate on data and evidence. • Data collection mechanism established. • Data collection systems are tested to fill in data gaps. • Number of research projects commissioned. • Utilisation of research. • Knowledge sharing. • Baseline data is collected. • Data is available on the type and volume of food waste. • Quantification of horticultural food waste. • Training and development incentives in relation to data collection are achieved. • Participation of stakeholders across the supply chain in data collection. • Data is available publicly on an ongoing basis. • Regular reporting of food waste types and volumes. • Industry dissemination. • Use of data in decision making across the supply chain.

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Strategic actions	Indicators
E3 Institute an effective policy and regulatory environment for food waste minimisation across the horticulture sector.	• Impacts of policy on food waste identified and quantified. • Food safety measures support food waste reduction. • Industry standards are providing certification processes for food waste. • Codes of conduct reviewed. • Industry support for the code of conduct. • Awareness and adherence to the Code across the supply chain. • Improved collaboration across horticultural stakeholders. • Policy incentives across the supply chain are in place. • A number of policy measures changed. • Standards for food waste developed and adopted. • Food waste reduction identified by revised T&C for contract farming. • Lack of policy harmonisation impacts on food waste identified. • Cross-jurisdictional harmonisation is achieved.
E4 Accelerate and incubate innovation and technology solutions in the horticultural industry for food waste minimisation.	• Barriers to technology adoption that stops food waste are identified. • The benefits of technology are assessed and shared across the industry. • Research guides used in future initiatives on technology adoption. • Understanding of skills needed for digital and technological innovation. • Report regarding new apps. • Case studies, such as the Refresh apps. • Quantitative data on use, impact, and cost outcomes of new apps. • Forecasting tool developed. • Uptake and use of tools across commodities. • Evidence of the use of tools in minimising crop damage and increasing value adding opportunities. • Level of investment in new technologies. • A number of innovations emerging to support food waste. • Overall level of reduction of food waste due to innovation/technology adoption.

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Strategic actions	Indicators
P1 Apply mechanisms for managing overproduction and balancing the demand and supply of horticultural products.	• Forecasting platform/tools developed. • Rigour and accuracy of the demand supply analysis. • Level of skills development in using tools. • Rates of utilisation of tools and information to manage production levels. • Information and tools available. • Dissemination mechanisms and a number of outreach activities. • Number of stakeholders reached. • Utilisation of information. • Assessment of levels of awareness. • A number of trials are conducted. • Participation levels by producers and retailers. • Dissemination activity levels of lessons identified from trials. • Types of incentives for transparency identified and implemented. • Increased communication of market data shared. • Improved transparency. • Improvements in demand supply fluctuations. • Types of alternative market options developed. • Efficacy of these options in the sale of surplus production. • Exports market identified and exports boosted.
P2 Address labour and skill shortages across the horticultural supply chain for different commodities' cycles of production and distribution.	• Assessment of the impact of workforce and skill shortages on food waste of different commodities and across the supply chain completed. • Mapping of critical workforce skills to reduce food waste in key horticultural industries. • Enhanced training for staff across the supply chain to improve food waste reduction. • A number of workforce plans are developed. • Ideation of new workforce models. • Trials of innovative workforce supply measures undertaken. • Sharing of learnings across the horticultural industry. • Automation and AI impact on workforce and food waste identified. • Adaptive workforce strategies determined.
P3 Reduce the impact of product specifications on food waste.	• A Multistakeholder party is established. • Review reports are finalised and shared. • Key commodities specification reviews are conducted. • Increased awareness and understanding of product specifications and levers across the supply chain. • Measurement of levels of consumer awareness. • Consumer awareness materials and promotion. • Increased uptake of rejected produce by consumers.

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Strategic actions	Indicators
R1 Explore ways to value add to surplus or waste produce.	• Existing studies reviewed. • New studies completed across key commodities for value adding, examining secondary market opportunities, constraints, enablers, trade-offs and financial viability. • Options for value adding, challenges and enablers in the ecosystem are identified and addressed. • Successful demonstration projects utilising surplus produce to create new value. • Lessons from product development and marketing shared across the industry. • Awareness and knowledge improved about value adding across the horticultural supply chain. • Improved capacity of supply chain stakeholders to handle suboptimal produce. • New product lines or sales mechanisms. • Partnerships are in place for market development for value added products. • The business case is established for each product/market. • Regional hubs established. • Partnerships in place for regional hub outcomes. • Secondary markets are established and expanded.
R2 Implement effective mechanisms for food donation.	• Challenges are identified. • Actions initiated to overcome the challenges. • Partnerships forged toward food donation. • Amount of surplus produce donated. • A number of innovative projects link with the circular economy, value added and other waste stream management initiatives. • Food security initiatives identified. • Mechanisms established for food donation to food insecure communities. • Amount of surplus produce donated. • Recognition systems are in place. • Regular awards promote and showcase good practice, achievement and impact. • A number of educational activities. • Level of awareness of food donors. • Risks of food donation are minimised for the donors. • A number of advocacy activities. • Nature of advocacy. • Regulatory and incentives in place for improved food donation.

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4.3 Indicators of Outcome and Impact for the banana industry sector action plan

The following table indicates the indicators associated with the banana industry sector action plan for reducing food waste.

Table 5 Indicators of outcomes and impacts for banana industry sector action plan for food waste reduction

Strategies	Indicators
P1 Align banana production quantities more closely with demand.	• Forecasting and information tools in place and rates of utilisation. • Improved awareness and understanding of food waste across the banana supply chain. • Improved collaboration across the supply chain about supply. and demand • Improved transparency in the market about prices and sales. • Alternative sales mechanisms are in place for oversupply of bananas.
P2 Support banana growers to continue best practice production.	• Improved research and extension support services to growers. • Increased awareness and adoption of new and emerging technologies. • Better knowledge about banana crop resilience. • Evidence base developed for climate adaptation in the banana industry.
P3 Improve the transportation of bananas to minimise damage and transit times.	• Efficiencies are introduced as a best practice in the transportation of bananas. • Improved use of real time monitoring to track loads and conditions of transport of bananas. • Adoption of innovation in packaging and ripening technologies • Development of and uptake of driver and relevant staff training
P4 Facilitate a consistent supply of skilled labour for the banana industry and supply chain.	• Assessment of workforce and skill shortages on food waste across commodities and the supply chain completed. • Detailed labour market supply and demand options for the banana industry are analysed, and workforce plans are developed within 3 years. • Number of trials of innovative workforce supply measures. • Developing industry or enterprise level managerial and technical training facilities to train or retrain existing and future staff across the supply chain to improve food waste reduction. • Initiatives are undertaken to link job/training networks and the banana industry for place-based collaboration.
R1 Increase the quantity of bananas being processed and incorporated into value added products for human consumption.	• Feasibility studies of banana value add completed. • Options and trials of banana value added products undertaken. • Secondary markets identified for banana waste value added products. • Regional and mobile processing hub options are explored and/or established to support the development of secondary products. • Capacity of supply chain actors developed to undertake value added products.

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Strategies	Indicators
R2 Increase the quantity of bananas donated to food rescue organisations.	• Increase in the number of food rescue and distribution points and activities. • Challenges and barriers to food rescue identified and interventions in place to address them. • A recognition system is established for banana rescue efforts. • Advocacy activities for tax incentives or rewards; incentives in place. • Good practice showcased and shared. • A number of innovative projects linked with the circular economy, value add and other waste stream management initiatives.
E1 Develop and encourage the widespread implementation of improved waste data collection, reporting and analysis.	• Review of data collection methodologies finalised. • Tools and systems in place for data collection. • Baseline data collected. • Participation in data collection across the supply chain. • Incentives in place to support data collection. • Bi-annual reports published. • Mechanisms in place to disseminate, share and utilise data and knowledge across the industry.
E2 Implement an education campaign and supply chain communication/ coordination activities.	• Number of educational activities and tools/materials shared. • Standards reviewed through waste reduction lens. • The level of training and information support provided to retailers to minimise food waste. • Level of collaborative activities across the industry regarding food waste. • Food waste champions established and promoted. • Good news stories showcased.
E3 Calibrate policy and regulatory settings to support banana food waste reduction.	• Cross jurisdictional biosecurity and quarantine laws are reviewed and harmonised. • Policy incentives to reduce food waste developed. • Increasing monitoring and controls in place for disease control.

4.4 Indicators of Outcome and Impact for the melon industry sector action plan

The following table indicates the indicators associated with the melon industry sector action plan for reducing food waste.

Table 6 Indicators of outcomes and impacts for melon industry sector action plan for food waste reduction

Strategies	Indicators
E1 Data Develop and encourage the widespread implementation of improved waste data collection and analysis tools to inform business decisions.	• Review of data collection methodologies finalised. • Tools and systems in place for data collection. • Baseline data collected. • Participation in data collection across the supply chain. • Incentives in place to support data collection. • Bi-annual reports published. • Mechanisms in place to disseminate, share and utilise data and knowledge across the industry.

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Strategies	Indicators
E2 Education Implement an education campaign and supply chain communication/ coordination activities to support the reduction of melon food waste.	• Number of educational activities and tools/materials shared. • Standards reviewed through waste reduction lens. • The level of training and information support provided to retailers to minimise food waste. • Level of collaborative activities across the industry regarding food waste. • Good news stories showcased.
E3 Policy Ensure that policy and regulatory settings support the melon supply chain to reduce food waste.	• Cross-jurisdictional biosecurity. and quarantine laws reviewed and harmonised. • Policy incentives to reduce food waste developed. • Increasing monitoring and controls in place for disease control.
P1 Supply and demand Improve the alignment between the supply of melons and the demand.	• Forecasting and information tools in place and rates of utilisation. • Improved awareness and understanding of food waste across the melon supply chain. • Improved collaboration across the supply chain about demand and supply. • Improved transparency in the market about prices and sales. • Alternative sales mechanisms are in place for oversupply of melons.
P2 Stronger supply chain relationships Encourage stronger relationships and enhanced communication across the melon supply chain in the interests of reducing food waste.	• Formation of melon supply chain steering committee. • Increasing monitoring and controls in in-store food waste. • The level of training and information support provided to retailers to minimise food waste. • Formation of a multi-stakeholder working group to review produce specifications. • Collaborative mechanisms are in place to disseminate, share and utilise data, product standards and knowledge across the industry.
P3 Industry best management practice (BMP) and extension Support best practice production to decrease melon food waste due to agronomic causes and improve consumer trust in the product at market.	• Improved research and extension support services to growers. • Increased awareness and adoption of new and emerging technologies. • Better knowledge about melon crop resilience. • Evidence base developed for climate adaptation in the melon industry.
P4 Cold chain and transport Improve the transportation of melons, including through the cold food chain to minimise damage and transit times.	• Efficiencies are introduced as a best practice in the transportation of melons. • Improved use of real-time monitoring to track loads and conditions of transport of melons. • Adoption of innovation in packaging and ripening technologies • Development and uptake of driver and other relevant staff training.
P5 Labour Support the supply of appropriately skilled labour for the melon industry and the associated supply chain.	• Assessment of workforce and skill shortages on food waste across commodities and the supply chain completed. • Analysis is completed on the potential impact of automation on melon workforce and food waste. • Labour market demand and supply options for the melon industry are analysed and workforce plans are developed. • Trials of innovative workforce supply measures. • Enhanced training for staff across the supply chain to improve food waste reduction.

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Strategies	Indicators
R1 Repurposing Increase the quantity of melons being processed and incorporated into value added products for human consumption.	• Feasibility studies of melon value add completed. • Options and trials of melon value added products undertaken. • Secondary markets identified for melon waste value-added products. • Regional and mobile processing hubs options explored and/or established to support the development of secondary products. • Capacity of supply chain actors developed to undertake value added products.
R2 Food Rescue Increase the quantity of melons donated to food rescue organisations.	• Increase in the number of food rescue and distribution points and activities. • Challenges and barriers to food rescue identified and interventions in place to address them. • A recognition system is established for melon rescue efforts. • Advocacy for activities for tax incentives or rewards, and incentives in place. • Education programs developed and run for food donation. • Good practice showcased and shared. • A number of innovative projects linked with the circular economy, value add and other waste stream management initiatives.

5. Conclusions & Recommendations

The Horticulture SAP involving a co-designed and bottom-up research-based approach, establishes a vision for moving forward while recognising challenges in the production and distribution stages of the supply chain. The Horticulture SAP presented nine strategic actions with key objectives, desired outcomes and potential indicators for achievement. Anticipated short, medium, long and longer-term outcomes were also specified. Further, a roadmap to implement the actions has been suggested for the horticulture industry to assist in achieving the target of halving Australia's horticultural food waste by 2030.

The banana industry SAP identified nine strategies, including four supporting preventions, two for repurposing food waste and three for the enabling environment. Multiple actions were also listed under each strategy with potential outcomes in different time frames. The melon industry SAP presented ten strategies, including three for the enabling environment, five for supporting prevention, and two for repurposing melon food waste. In both cases, a roadmap for the implementation of Sector Action Plans was developed outlining key actions with major milestones through a combination of prevention, repurposing and enabling strategies.

Opportunities for future research include the quantification of economic, environmental, and social impacts in each strategic action area of the action plans, and the adoption of new technologies and initiatives.

In conclusion, the implementation of the action plan developed in this project can help the horticulture sector, including the banana and melon industries, significantly reduce food waste by 2030. This will lead to the realization of associated economic, environmental, and social benefits.

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APPENDIX A – Project reports

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4. The Horticulture Sector Action Plan for Food Waste Reduction 2024: Summary report
5. Banana Industry Food Waste Action Plan 2023: Summary
6. Melon Industry Food Waste Action Plan 2023: Summary
7. Final project report: Horticulture Sector Action Plan 2024

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