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Food loss and waste in Aotearoa New Zealand

Towards a 50% reduction

The final report in the food waste series from the Prime Minister's Chief Science Advisor, Kaitohutohu Mātanga Pūtaiao Matua ki te Pirimia.

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Other reports in the OPMCSA food waste series:

Food waste: A global and local problem

Food rescue in 2022: Where to from here?

Beyond the bin: Capturing value from food waste

Preventing food loss and waste in Aotearoa New Zealand: Evidence from across the supply chain

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Front cover (top to bottom):

1. A commercial garden nourished with local compost.
2. Volunteers at Satisfy Food Rescue. Image credit: Satisfy Food Rescue.
3. A handful of vermicast produced at MyNoke's Taupō worm farm.
4. A misshapen tomato.
5. Food preparation in a household kitchen.

Mā tōu rou, mā taku rourou

ka ora te iwi

Foreword

Kia ora koutou,

While we produce more food globally than ever before, an estimated 40% of this food is lost or wasted before it is consumed by people. This figure – contrasted with widespread hunger and food insecurity, as well as the significant environmental and economic resources producing food requires – presents a pressing and important challenge to reduce the amount of food we waste. The UN Sustainable Development Goal 12.3 aims to reduce food waste by 50% by 2030. Solving our food loss and waste challenge could help feed hungry people, go a significant way towards meeting our requirements to reduce methane emissions, and save businesses along the food supply chain money.

Businesses, communities, researchers, and individuals have long been working to reduce food loss and waste in their own contexts. In New Zealand, the Ministry for the Environment has taken the lead on food waste action in Government, established a national definition, and are working on a national baseline measurement of food loss and waste. They have also co-funded a suite of food waste reduction projects to prevent food waste in households, businesses, and Māori led settings. Outside of Government, the Kai Commitment, administered by New Zealand Food Waste Champions 12.3, is a voluntary agreement among major food businesses to reduce food waste. Aotearoa also has an established food rescue sector distributing surplus food to people who are food insecure, as well as many other commercial and community initiatives to reduce food loss and waste. We have built on their valuable work in this project and, in particular, the 2020 briefing to the Environment Committee by Professor Miranda Mirosa.

Internationally, the Food and Agriculture Organisation of the UN has established global best practice for reducing food loss and waste, along with other leading organisations such as the Waste and Resources Action Programme in the UK, ReFED in the US, and End Food Waste Australia. Aotearoa has much to learn from other countries and needs to better understand its food loss and waste and take more coordinated and strategic action to address food loss and waste. Because the food system and the impacts of food loss and waste are so broad, so too are the solutions. There is not one 'silver bullet' solution to food loss and waste reduction. Meaningful change will require rethinking and innovating in many different ways and many different settings, ranging from grassroots to big system solutions.

This report summarises a series of reports published between 2022-2024. The first report *Food waste: A global and local problem*, was an exercise in scoping the project and the problem. The following three reports speak to a specific aspect of the challenge to reduce food loss and waste. *Food rescue in 2022: Where to from here?*, followed by *Beyond the bin: Capturing value from food loss and waste*, and finally *Preventing food loss and waste In Aotearoa New Zealand: Evidence for action across the supply chain* are all available on our website and are referred to throughout this report.

This report series was made possible thanks to the generosity and enthusiasm of the extensive project reference group. A wide range of stakeholders and experts with crucial knowledge and experience have been involved, totalling over 400 experts. Those who have contributed their time, knowledge, and feedback throughout the report series are acknowledged in the following pages. The size of the reference group speaks to the breadth of the challenge at hand. Addressing food loss and waste presents an environmental, social, and economic challenge and the effects reach throughout and beyond the food system to all corners of New Zealand.

This final report provides a summary of evidence and key messages collected throughout the report series. It also serves to bridge the workstreams of the report series and identify opportunities that address the challenge as a whole. We are delighted that some of the recommendations have already been worked on, and indicate these in the full list of recommendations included herein. We need a system shift, and so begin this report by painting a vision of an Aotearoa without food waste, to provoke and inspire change. We present this vision to set the stage for our detailed recommendations to address the complex set of challenges and opportunities summarised in this report.

Ngā mihi nui,

Professor Dame Juliet Gerrard DNZM HonFRSC FRSNZ
Prime Minister's Chief Science Advisor
Kaitohutohu Mātanga Pūtaiao Matua ki te Pirimia

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Institutional affiliations of all reference group members are listed in the acknowledgements to the full reports: *Food waste: A global and local problem*, *Food rescue in 2022: Where to from here?*, *Beyond the bin: Capturing value from food loss and waste*, and *Preventing food loss and waste In Aotearoa New Zealand: Evidence for action across the supply chain*.

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Contents

Vision

The year is 2040 in Aotearoa New Zealand…Food loss and waste is still something we deal with, but mostly we can prevent wasting food that is good to eat, and have found sustainable and regenerative ways to utilise inedible parts of food or food that's unsafe to eat – like nutrient recovery that replenishes the soil. Sometimes unpredictable things happen, like a cancelled export order, but we are prepared for uncertainty and keep that food for people through our food rescue networks. Our public and private sectors have been working together strategically for over a decade, coordinating priorities for policy, funding, infrastructure, and collecting data to support reduction of food loss and waste, and minimise its harms.

New Zealand's healthy and sustainably produced food products are world leading. Our farmers are a source of national pride, producing a diverse array of fruit and vegetables, grains, nuts, and animal products. A significant amount of this premium produce is exported, but there is plenty for New Zealanders as well. We only import what we aren't able to sustainably grow here, and local products are staple ingredients for food service and households, particularly those which are in season. Not only does this make our food system more resilient, but it shortens our supply chains and reduces waste. Through Government support and incentives, even small and medium enterprises are able to optimise their crop management technology. Technologies such as refined plant breeding, strip picking, and mechanised harvesting, as well as digitalised crop management and AI-supported harvesting technology to help refine decision making, mean much lower proportions of crops are unmarketable when harvested. Particularly in domestic supply chains, this is also aided by a generally wider consumer acceptance of crops in different shapes and sizes so a wider range of produce is considered marketable. Producers also have access to a digitalised material flow platform, so they know what leaves their business as food or as waste and where it goes, and can make use of this live data for decision making. This platform also makes it really easy for them to input all their emissions, economic, and food loss and waste reporting, so they have more time to get on with farming.

Local manufacturers have implemented digital systems to monitor their production, resulting in more efficient processes and significantly less waste. Packaging has moved away from soft plastics to compostable materials that use active or intelligent design to promote optimal storage conditions and keep food fresh and safe for longer. There are precise product tracking capabilities with new quick response (QR) codes and radiofrequency identification data (RFID) that enable complete transparency across the supply chain, specific tracing for events such as recalls, and access to detailed information for consumers. Thanks to innovations by our world-leading food scientists, by-products and damaged (but perfectly edible) produce are routinely upcycled into new, nutritious products, such as bread made with spent grain from breweries, increasing food supply and reducing unnecessary waste.

The challenges of climate change, biodiversity loss, contaminated waterways, dependence on synthetic fertilisers, and a changing market for animal products created opportunities to diversify and minimise food loss and waste across the supply chain. This has enhanced our reputation for exporting sustainable products. Investment in science and technology, strongly connected with deep expertise on farms, has allowed us to become world leaders across an array of export products.

Much of the inedible or unavoidably lost parts of our grain crops, as well as some loss from our horticultural crops, are used to feed livestock animals – gone are the days when we relied on imported animal feed and our arable land now grows high value crops for human consumption.

The terms of trade between retailers and producers equitably balances risks across the supply chain, reducing incentives for wasteful overproduction. Supermarkets use state of the art forecasting and easily communicate dynamic changes to their supply streams, based on AI-models that reliably predict consumer demand. They also take the lead on food loss and waste reduction, not only within

their own businesses, but with their influence across the supply chain. There are many more places for us to obtain our food from now, with lots of alternative models for low waste meal kits and meal delivery services, as well as an abundance of farmers' markets and community supported market gardens where consumers connect directly (and share the risks) with producers, so they only grow what is needed for the local market.

These gardens are a fantastic place for school children to learn about food and agriculture, and many more school leavers seek employment in farming and food than was the case at the beginning of the century. Across the supply chain, the incentives to push consumers to buy more are reduced, instead connecting them with their food and its producers in a way that empowers consumers to pay fair prices for what they need and produce less food waste at home. Consumers are supported to make good decisions about when to discard food, with best before dates replaced by sensible guidance on when things are still good to eat.

Awareness of the benefits of reducing food waste is widespread, thanks to targeted campaigns and a generation of school children who benefitted from the food waste prevention schemes introduced in schools. People are storing their food more appropriately, buying the right amounts, eating their leftovers more readily, and know how to use date labelling as well as their own senses to only eat food that's safe. In some households, people grow their own food and compost any waste; others are part of community garden compost systems. Kerbside collection for food scraps is routine, with commercial composting and anaerobic digestion facilities established across the country for those who prefer to opt-in to the centralised system. Nutrients and energy from these facilities are captured and reused routinely, and all the facilities are certified as carbon neutral.

Community networks that connect people with surplus edible food to people who want it or know how to preserve it are supported by national guidance on food safety and supply chain logistics. In cities the sharing economy is booming, with proliferation of sharing apps and social enterprises to connect surplus food to hungry people. The amount of food loss and waste that ends up in the compost or in the kerbside collection bin is far less than it was 15 years ago, and not all end-of-life composting and anaerobic digestion facilities need to be replaced.

When international supply chains are disrupted by increasingly frequent weather events, farmers and consumers are resilient because our food system has diversified, and mechanisms are in place to rescue the food and support the farmers who supply it. Export markets may be temporarily cut off or disrupted, but domestic markets are resilient. Digitalised logistics enable producers with surplus to be connected quickly to processors with capacity to turn this into upcycled food products with longer shelf life. Our accurate forecasting and planning abilities, largely due to our secure and trusted database systems, integrated with AI, help us to make better logistical decisions.

All in all, New Zealanders value food and the unique food culture we have developed. We teach our children where food comes from and how it comes to be on our plates, and they turn into adults that respect and protect the people and places that provide our food. Aotearoa has a food system that supports the production and delivery of sustainable, safe, nutritious food both to New Zealanders and to export markets. We have met our carbon reduction and sustainable development goals, in large part, due to the excellent way we have transformed our food loss and waste situation. New Zealand has an international reputation as a food producing nation largely without food loss and waste.

Recommendations

Each report in the food waste series contains recommendations, categorised under five themes. The themes are listed and explained below. Recommendations have not been prioritised.

Theme 1: Systems problem, systems solution

Combatting food loss and waste requires people throughout the food system and in the waste management sector to work collaboratively towards a shared vision. To achieve this, we need a national food loss and waste strategy and reduction target, and coordination mechanisms that empower stakeholders to bring the shared vision to life.

Theme 2: Measure and monitor

We need to know more about food loss and waste in Aotearoa. Not just how much food is wasted, but where in the food system that waste occurs, current diversion practices, dominant food loss and waste types, and geographic variation in loss and waste volumes. Good data is crucial to articulating the challenge, galvanising action, designing well-targeted interventions, and monitoring progress.

Theme 3: Prevent food loss and waste at source

Preventing food loss and waste at the source has scope to deliver the greatest environmental, social, and economic benefits throughout the food system, and everyone has a role to play. A high degree of connectivity means that New Zealanders can contribute to food loss and waste prevention not just at their stage of the food supply chain, but throughout the system.

Theme 4: Save good food for people

Good food is not a waste stream to be managed – it is a resource for nourishing people. Surplus food, imperfect but nutritious produce, and edible by-products are examples of food, not food loss or waste. Resources, systems, and enabling conditions that promote food rescue and upcycling are crucial to ensuring edible food is never treated as loss or waste. If nourishing people is not practical, using the food as feed resources for animals is the next best alternative.[a]

Theme 5: Capture value from unavoidable food loss and waste

There will always be some loss and waste in our food system, which must be managed to capture value in alignment with circular economy thinking and the food recovery hierarchy. Diversion to animal feed and investment in material, nutrient, and energy recovery from food loss and waste will ensure there are decent end-of-life options for unavoidable food loss and waste. Landfilling food loss and waste has no place in our waste management future.

A summary of the recommendations from across the series is shown here, followed by detailed recommendations under each theme heading. Apart from **S1** and **S2**, the summary report recommendations, all recommendations have been published in the other reports and are collated here. Some recommendations from previous reports support the new summary recommendations, and so have been grouped accordingly. Note that while recommendations themselves remain the same from their originally published versions, some of the considerations have been updated. Recommendations are numbered according to the report from which they are drawn:

R: Food rescue, previously published in *Food Rescue in 2022: Where to from here?*

C: Capturing value, previously published in *Beyond the bin: Capturing value from food loss and waste.*

[a] Note this last sentence is an update from versions in previous reports, to better reflect the reality that there are instances where saving this food for people is not possible.

P: Prevention, also to be published in *Preventing food loss and waste in Aotearoa New Zealand: Evidence from across the supply chain*.

S: Summary, published only in this report, *Food loss and waste in Aotearoa New Zealand: Towards a 50% reduction*.

Systems problem, systems solutions

S1: Implement a strategic action plan for combatting food loss and waste in Aotearoa.

Recommendations that will contribute to S1:

P1: Utilise sector action plans (SAPs) to identify intervention opportunities that take a systems view while allowing for the unique contexts of different sectors.

R1: Develop an interagency strategic action plan for food rescue.

P8: Pursue opportunities to reduce food loss and waste through research and innovation.

C10: Halve our total food loss and waste by 2030 and set a zero food loss and waste target.

Other 'Systems problem, systems solutions' recommendations:

P2: Evaluate the effect of the Grocery Supply Code on trade term driven food loss and waste.

C1: Take a nationally consistent approach to food loss and waste valorisation that is informed by the food recovery hierarchy and lifecycle assessment approach.

C2: Lead by example on food loss and waste valorisation and utilisation of food loss and waste-derived products.

Measure and monitor

S2: Standardise and digitalise food loss and waste data across the supply chain, including destinations, and consider mandatory food loss and waste reporting.

Data recommendations with significant commonalities to S2:

R2: Understand surplus food, food insecurity, and the rescue sector's capacity with greater granularity.

R3: Strengthen data and research on the rescue sector's impact.

C3: Understand the scale of New Zealand's food loss and waste problem with greater granularity so that valorisation opportunities can be identified.

Other 'Measure and monitor' recommendations:

P3: Support the creation and adoption of a data platform for the sector.

Prevent food loss and waste at source 	**P4:** Encourage novel and emergent models of food purchase by consumers. **P5:** Identify mechanisms to avoid food loss and waste caused by extreme weather events. **P6:** Update specification practices that lead to edible food being discarded. **P7:** Continue to explore improvements to current date labelling. **P9:** Support evidence-based consumer communications campaigns.
Save good food for people 	**R4:** Stop surplus food from being managed lower in the food recovery hierarchy by empowering donors and the rescue sector to redistribute surplus food to people, while noting that source prevention of surplus food is the priority intervention. **R5:** Support the rescue sector to operate with high food safety standards, protecting recipients and enhancing donor engagement. **C4:** Foster the growth of New Zealand's upcycled food sector, prioritising sustainability, nutrition, and whole food utilisation.
Capture value from unavoidable food loss and waste 	**R6:** Support the rescue sector to manage any food loss and waste associated with its activities according to the food recovery hierarchy. **C5:** Work to replace purpose-produced and imported animal feed ingredients with food loss and waste, particularly utilising food system by-products and post-consumer food waste, without compromising feed safety and animal nutrition. **C6:** Support material recovery efforts for food loss and waste streams that are inedible and can't readily be prevented at source. **C7:** Ensure that processes and pathways are in place to enable nutrients from unprevented food loss and waste to be safely returned to the environment via productive land, parks, and gardens, aligning with the Ministry for the Environment's Waste Strategy. **C8:** Explore the potential for solutions to food loss and waste to supplement natural gas supplies. **C9:** Explore the merits of banning food loss and waste from landfill.

Each recommendation contains detailed sub-recommendations. For each sub-recommendation, we provide an indicative timeframe for implementation.

- **Next 12 months** – These recommendations should be considered for immediate implementation, to capture existing momentum and make the most of low-hanging fruit.

- **By 2027-2028** – These recommendations might take a little longer to implement but should be pursued in the near term to keep Aotearoa on track to a future without food loss and waste.
- **By 2030** – The UN Sustainable Development Goal (SDG) 12.3 calls for per capita retail and household waste to be halved by 2030, and for food loss to be reduced elsewhere in the food system. These recommendations should be considered for implementation by 2030, in pursuit of SDG 12.

Theme 1: Systems problem, systems solutions

Combatting food loss and waste requires people throughout the food system and in the waste management sector to work collaboratively towards a shared vision. To achieve this, we need a national food loss and waste strategy and reduction target, and coordination mechanisms that empower stakeholders to bring the shared vision to life.

S1: Implement a strategic action plan for combatting food loss and waste in Aotearoa.

Next 12 months	By 2027-2028	By 2030
a) Identify key stakeholders for close involvement. **b)** Commission/undertake relevant scoping and research, building on actions outlined in this report series. **c)** Launch public discussion/consultation document.	**d)** Design and launch strategic action plan with a suite of sector action plans (SAPs). The design should incorporate evaluation.	**e)** Undertake outcome and impact evaluation.

Considerations

See section 3 for detail about considerations for a strategic action plan.

The action plan should contextualise wider economic, social, and environmental impacts of food loss and waste (FLW) as well as FLW itself. It could be a standalone food loss and waste strategic action plan, or part of a wider food strategy, complementing the waste strategy established by the Ministry for the Environment (MfE) in 2023. As part of **S1.b**, the Government should determine if a 'circular food economy' is a priority and then instruct agencies to include this in the action plan's work programme.

This work could establish an independent organisation responsible for developing and implementing the strategic action plan, and more broadly for the research, governance, and oversight of FLW in Aotearoa. See Australia's End Food Waste Australia (EFWA) and Waste and Resources Action Programme (WRAP) in the UK for possible models.

S1.d should allow findings from implementation and process evaluation to be incorporated into continued delivery. Similarly, the design of the strategic action plan should allow findings from outcome and impact evaluation in **S1.e** to inform ongoing delivery.

SAPs recommended in **P1** should be part of wider strategic action plan.

Food rescue strategy recommended in **R1** should be one of the SAPs recommended in **P1** and be part of the wider strategic action plan.

P8.g should be part of the wider strategic action plan.

*In our previous reports on food rescue, capturing value, and prevention, we made recommendations that will contribute to Recommendation **S1**. These are grouped here:*

P1: Utilise sector action plans (SAPs) to identify intervention opportunities that take a systems view while allowing for the unique contexts of different sectors.

Next 12 months	By 2027-2028	By 2030
a) Undertake a trial SAP for one key sector.	**b)** Undertake process and outcome/impact evaluation for the SAP undertaken as part of **P1.a**. **c)** Using the learnings from **P1.b**, undertake SAPs for other key sectors.	**d)** Implement interventions identified in SAPs to support system change.

Considerations

P1 would be an element of **S1**.

This work could be led by MfE and informed by best practice overseas and work by the Kai Commitment in New Zealand.

It will be important to have meaningful partnership from organisations across each sector to ensure interventions identified are workable. EFWA has undertaken SAPs for several sectors. These could be useful models for SAPs in Aotearoa. If resources are limited, an abbreviated process could be to seek input from sector stakeholders on the feasibility and local applicability of interventions identified in the Australian SAPs in New Zealand.

Sectors can be but don't have to be defined by food product. For example, EFWA has undertaken SAPs for bread and bakery, cold chain, food rescue, dairy, food service, and horticulture. SAPs could be part of the strategic action plan recommended in **S1**.

SAPs will be more useful if designed to include regular reviews and refreshing. **P1.d** will require a dedicated administrative body with industry buy in, as implementation processes will require coordination.

R1: Develop an interagency strategic action plan for food rescue.

Next 12 months	By 2027-2028	By 2030
a) Develop a strategic action plan for food rescue. A suitable strategic action plan could: **i.** be developed by a lead ministry, with strong support from other ministries; **ii.** be developed in partnership with food donors from across the food supply chain, rescue organisations, including Aotearoa Food Rescue Alliance (AFRA) and its members and non-members, and the New Zealand Food Network (NZFN), Kore Hiakai, local governments, Māori organisations, and people experiencing food insecurity; **iii.** provide medium to long term clarity on rescue sector resourcing to enable strategic, collaborative initiatives in the food rescue sector; **iv.** be informed by insights from the evaluation of COVID-19 related food rescue initiatives and experiences; **v.** complement efforts to tackle the root causes of surplus food and food insecurity; and **vi.** include an aspirational end date for the need for food rescue to alleviate hunger and minimise surplus food.	**b)** Monitor and evaluate the implementation and impacts of the food rescue strategic action plan and refresh it if necessary.	**c)** Review the long term capacity needs of the food rescue sector in the light of progress made to address the root causes of food insecurity and surplus food.
Considerations **R1** would be an element of **S1**. The strategic action plan for food rescue from **R1.a** could build on existing work in the Ministry of Social Development (MSD) with support from MfE and the Ministry for Primary Industries (MPI) and would need to dovetail with wider strategic efforts in the FLW space, likely led by MfE.		

P8: Pursue opportunities to reduce food loss and waste through research and innovation.

Next 12 months	By 2027-2028	By 2030
a) Prioritise funding for FLW prevention under: **i.** MfE's Waste Minimisation Fund and/or; **ii.** government research schemes. **b)** Support research for technology that can be used on farm to prevent FLW, including implementation research. **c)** Continue to support exploration of opportunities for agri-tech addressing FLW as an export product. **d)** Explore mechanisms to support adoption of innovation by small and medium enterprises (SMEs) to prevent FLW. **e)** Ensure that public investment in research and innovation in FLW is evaluated, to realise positive outcomes.	**f)** Implement mechanisms to support adoption of innovation to prevent FLW by SMEs. **g)** Develop a strategy covering prioritisation of relevant research, mechanisms to support research and adoption of innovation, and ongoing evaluation of performance in this space.	**h)** Review and refine research strategy to meet needs post-2030.

Considerations

P8 would be an element of **S1**.

P8.a should align with proposed strategic action plan in **S1** and sector action plans in **P1**, to ensure coordinated funding.

P8.b-e could be achieved through mechanisms such as the MPI-administered Sustainable Food and Fibre (SFF) Futures Fund.

Opportunities for research and innovation to reduce FLW and its related harms go beyond prevention of FLW. Section 4.1.2 includes prioritising and facilitating research and innovation as a key aspect of a strategic action plan to combat FLW.

P8.c would allow innovation and technology development that is unlikely to be sufficiently profitable at the New Zealand scale. There is a trade-off between the benefits of the technology to New Zealand producers and the benefits of exporting the technology to its developers on one hand, and the risk of losing competitive advantage by making our innovations available internationally on the other.

P8.b and **P8.d** will include innovations around digitalising operations to enable better inventory management, demand forecasting etc., as well as innovations related to food (e.g. breeding and shelf life) and the way we interact with food (e.g. robot harvesters and smart packaging).

P8.e and **P8.f** may align with **P3.c**.

Pilot studies of innovative tools could be a useful way to evaluate effectiveness before rolling out.

C10: Halve our total food loss and waste by 2030 and set a zero food loss and waste target.

Next 12 months	By 2027-2028	By 2030
a) Clearly signal the intention to halve our total FLW as part of S1.	**b)** Develop a strategy to achieve halving of FLW by 2030. This could include adopting recommendations C1-C9, as well as: **c)** Undertake regular scans for new opportunities to capture value; **d)** Engage with stakeholders across the supply chain and consumers to identify remaining barriers to reducing waste; and **e)** Consider large-scale interventions targeting public attitudes and knowledge around FLW as a potential resource. **f)** Commission or undertake work to establish a realistic timeline for a zero FLW target.	**g)** Evaluate whether New Zealand has halved its total FLW. **h)** Commit to a new FLW target.

Considerations

C10 would be an element of S1.

Recommendation C10.b could be informed by other countries' strategies, but will need to be suitable for our context.

C10 is a more ambitious goal than is laid out by SDG 12.3, which has been revised and now targets a 50% reduction of food waste at the retail and consumer levels, and reduction of food loss at the production and processing levels, including post-harvest losses.

In our previous reports on food rescue, capturing value, and prevention, we also made recommendations that fall under the theme 'Systems problem, systems solutions', but are not affected by subsequent recommendations. These are:

P2: Evaluate the effect of the Grocery Supply Code on trade term driven FLW.

Next 12 months	By 2027-2028	By 2030
a) Commission an evaluation designed to understand the effects of the Grocery Supply Code (the Code) on FLW.	**b)** Receive and report interim findings. **c)** Identify areas where amendments to the Code may improve results. **d)** Signal willingness to use enforcement or stronger regulation if interim results suggests that the Code is not effective.	**e)** Receive and report final findings. **f)** Consider whether updates to the Code or new regulation is necessary in light of **P2.e.** **g)** Design and implement an ongoing monitoring mechanism.

Considerations

The Code is intended to promote fairness, transparency, and certainty in the grocery market. Although not its purpose, the Code has potential to prevent FLW.

P2 could be a joint workstream between MfE and Ministry for Business, Innovation, and Employment (MBIE) in consultation with the Commerce Commission. The scope of this workstream could include topics of interest to the Commission beyond FLW.

P2.a should consider the whole supply chain, as some requirements of the Code may prevent food loss upstream**.**

The European Commission's directive against unfair practices in the food supply chain (EU 2019/633), and the review of the Australian Grocery Code of Conduct published in 2024 that includes specific reference to FLW (page 58), may be useful background.

C1: Take a nationally consistent approach to loss and food loss and waste valorisation that is informed by the food recovery hierarchy and lifecycle assessment approach.

Next 12 months	By 2027-2028	By 2030
a) Develop and adopt a food recovery hierarchy for New Zealand. **b)** Ensure FLW valorisation policies and investments are consistent with the food recovery hierarchy. **c)** Ensure collaboration between agencies with mandates relating to combatting FLW, supporting a shift towards a circular economy, and the development and utilisation of valorised FLW.	**d)** Support the development of publicly accessible resources to facilitate a lifecycle assessment approach to exploring FLW valorisation options, with a particular focus on emissions.	

Considerations

C1.a We strongly support the MfE drive to reduce food loss and waste in New Zealand. A food recovery hierarchy that is recognised across Government, referred to in all Government FLW policy and factored into investment decisions would enable faster progress to be made. The recent 'wasted food scale' published by the US Environmental Protection Agency is a good example of an updated hierarchy that reflects advances in technology and a variety of pathways. With territorial authorities playing a crucial role in combatting FLW, recommendation C1.a should be generic for all of New Zealand but provide additional guidance on how it can be adapted for regional contexts by local governments. Implementation of C1.b is particularly relevant to FLW valorisation solutions that require large amounts of capital expenditure and/or have minimum FLW input requirements to be viable.

As an example, recommendation C1.c could involve collaboration between MfE and MPI on FLW – to animal feed and soil amendment policy, with MfE responsible for waste management and MPI responsible for agriculture and biosecurity. To facilitate this collaboration, there is scope to better define ministerial roles in enacting actions around waste in the Emissions Reductions Plan (chapter 15).

Recommendation C1.d could draw inspiration from the New South Wales Environment Protection Agency's resources on the emissions impacts of FLW recovery technologies. To build understanding and confidence in the resources, assumptions and key sources should be clearly articulated. C1.d could be done in conjunction with C8.a.

C2: Lead by example on food loss and waste valorisation and utilisation of food loss and waste-derived products.

Next 12 months	By 2027-2028	By 2030
a) Use Government purchasing power (e.g. procurement) at the central and local level to increase the uptake of FLW valorisation products (e.g. compost, upcycled food) to help transform the supply market and lead by example.	**b)** Require all Government agencies and public institutions to have systems in place to divert FLW from landfill and to look for opportunities to prevent FLW.	
Considerations Ensure systems in **C2.b** align with the strategic action plan resulting from **S1**. **C2.a** could, for example, be implemented as part of school lunch programmes, in prisons, and in public hospitals. The Carbon Neutral Government Programme could provide an avenue through which to make this happen. Consider pilot studies before full adoption of interventions.		

Theme 2: Measure and monitor

We need to know more about food loss and waste in Aotearoa. Not just how much food is wasted, but where in the food system that waste occurs, current diversion practices, dominant food loss and waste types, and geographic variation in loss and waste volumes. Good data is crucial to articulating the challenge, galvanising action, designing well-targeted interventions, and monitoring progress.

S2: Standardise and digitalise food loss and waste data across the supply chain including destinations and consider mandatory food loss and waste reporting.

Next 12 months	By 2027-2028	By 2030
a) Understand gaps in FLW data and work to close these once the national baseline measurement is released by MfE. **b)** Work with sectors to research feasibility of data digitalisation technologies and mechanisms that support system-wide data sharing and traceability.	**c)** Adopt standard methodologies for measuring FLW. **d)** Pilot digitalisation technologies for measuring FLW data across the supply chain.	**e)** Roll out, monitor, and evaluate digitalised data monitoring for FLW across the supply chain. **f)** Explore mandatory FLW reporting.

Considerations

Digitalisation technology should work to reduce the burden of reporting by integrating other data and compliance needs with the same technology (e.g. emissions, economic, logistics, etc.).

Data privacy will need to be considered – transparency of practice is key for accountability but there will need to be a mechanism that respects commercially sensitive information.

Adopted measures, and collection and storage tools, will need to consider cultural, environmental, and economic factors specific to the New Zealand context, while allowing for comparison with international data.

P3 data platform should be part of digitalising data. A 'live data dashboard' could help integrate data across the supply chain and throughout the food recovery hierarchy. This is in line with goals for FLW data in Australia. Table 7 and section 4.2.3 show data needs and digitalisation opportunities.

Examples of standardised data include the food loss and waste protocol, ReFED insights engine, and the European Commission's guidance on reporting of data on food waste and food waste prevention.

*In our previous reports on food rescue, capturing value, and prevention, we made recommendations around data with significant commonalities to Recommendation **S2**. These are:*

R2: Understand surplus food, food insecurity, and the food rescue sector's capacity with greater granularity.

Next 12 months	By 2027-2028	By 2030
a) Build on and support existing efforts to understand where food rescue organisations and other community food providers are located, with the aim of supporting connectivity between food rescue organisations and donors and providing insight into national food rescue coverage. **b)** Assess the current capacity of the food rescue sector, including an evaluation of its infrastructure needs (e.g. refrigerated transport and storage, freezer capacity) and opportunities to leverage existing infrastructure from the commercial sector (e.g. seasonal cold stores when not in use). **c)** Gather more granular data on surplus food, leveraging the MfE baseline measurement work.	**d)** Develop a more detailed picture of food insecurity in Aotearoa, leveraging the Ministry of Health (MoH) New Zealand Health Survey and Nutrition Survey, the latter of which is currently being scoped. **e)** Assess whether the distribution and quantity of food support matches needs, drawing insights from international best practice (e.g. Foodbank Australia's Hunger Map project). **f)** Commission research on the impact of rescued food on the health and wellbeing of people experiencing food insecurity, with a nutrition focus. This should build on Kore Hiakai's food parcel research and draw on data gathered by AFRA. **g)** Commission research to investigate the degree of choice and cultural suitability of rescued food delivered to people experiencing food insecurity.	**h)** Assess whether the changing climate and geopolitical events have brought the predicted increase in disruptions and exogeneous shocks to food systems and review whether the capacity of the food rescue sector and its infrastructure is still fit for purpose in this context.

Considerations

Because the rescue sector is continually changing, efforts will be needed to ensure any rescue sector mapping work (see **R2.a**) remains accurate and up to date.

R2.c would be a part of **S2**. As with other data needs for FLW, more granular data about surplus food not currently captured by the food rescue sector will help to illuminate the opportunities for food rescue to divert more of this and inform growth of the sector. Table 7 gives a list of data needs to improve data and monitoring for FLW. It includes a need for understanding surplus food that could be rescued.

R3: Strengthen data and research on the food rescue sector's impact.

Next 12 months	By 2027-2028	By 2030
a) Support the food rescue sector's existing efforts to gather robust data on the volume and types of food rescued. The data requirements and impact evaluations required by Government should be aligned with one another. **b)** Develop a more robust meal estimate that can be used to support communication and evaluation of the social impacts of food rescue, drawing insights from the Kore Hiakai Standard Food Parcel measure and international best practice.	**c)** Evaluate and refine the rescue sector's data collection and investigate whether affordable technology can increase efficiency of data collection. **d)** Commission research into the environmental impacts of food rescue in the New Zealand context, with a focus on water usage and greenhouse gas emissions and including a life cycle lens. Include a focus on the most appropriate assumptions to enable fair comparisons with other food recovery options.	**e)** Analyse research in social, environmental, and nutrition domains to further understand the trade-offs and choices associated with food rescue. **f)** Use robust national data to inform assessment of future food rescue sector capacity needs (see **R1.c**). **g)** Commission research to understand how the food rescue networks are best positioned to operate as food supply routes in the event of a natural disaster or similar.

Considerations

Currently food rescue is largely funded by MSD to reduce food insecurity, but there is potential for the sector's funding to come from multiple different places, because goals and outcomes of the food rescue sector align with and are supported by multiple Government departments (e.g. relieves food insecurity and reduces emissions associated with FLW). **R3.a** refers to the fact that reporting requirements that these different departments may require should be aligned.

Affordable technology to support **R3.c** might include weighing scales in trucks, rapid scanning equipment, standardised software, etc.

C3: Understand the scale of New Zealand's food loss and waste problem with greater granularity so that valorisation opportunities can be identified.

Next 12 months	By 2027-2028	By 2030
a) Gather more granular data on FLW throughout the food supply chain, leveraging the MfE baseline measurement work. See also **R2.c** from *Food rescue in 2022: Where to from here?*	**b)** Develop FLW questions to include in the 2027 Agricultural Production Census, including primary producer estimates of FLW volumes and how FLW is utilised and/or managed. **c)** Commission independent research to understand FLW volumes and how FLW is utilised and/or managed in the: food and beverage processing; retail sector; and food service sector. **d)** Investigate the best method for measuring changes in household FLW over time and implement. **e)** Support the development of publicly accessible data and resources to facilitate a lifecycle assessment approach to exploring FLW valorisation options, with a particular focus on emissions.	**f)** Gather up-to-date data on FLW volumes and utilisation throughout the food supply chain and use this data to evaluate the success of FLW valorisation interventions. Are they working? See also **C3.b–d**. **g)** Consider the adoption of ISO/WD 20001 once finalised, which provides a generic but standardised tool for measuring and reducing FLW across the supply chain.

Considerations

C3 would be supported by **S2**.

We understand that the MfE baseline measurement is going to be based on existing data, such as industry reports and published papers, as well as interviews and survey responses. **C3** would be a first step in quantifying the emissions impacts of FLW, as advised by the Climate Change Commission. **C3.b–d** are intended to increase the available primary data, with which the baseline could be updated. For **C3.b–d**, FLW should be differentiated by whether it is surplus food or a by-product, post-consumer food waste, or other FLW type. Handling, storage, transport, and distribution throughout the food supply chain should also be considered.

C3.d could be coupled with a household survey that explores engagement with home- and community-based food waste management solutions, self-reported reasons for wasting food, and self-reported food waste awareness.

Government could take immediate action towards C3.c and C3.d by making more of the data collected by central and local governments publicly available, for example, household food scraps data. Additionally, where private contractors are delivering public services, for example, collecting waste, their reporting requirements could be aligned with those of the territorial authorities to strengthen the data available.

C3.e would include data collected through C3.b–d as well as other data relevant to lifecycle assessment. The methods used to conduct the lifecycle assessment should be carefully considered to ensure it is fit for purpose.

C3.f could be piloted with key sectors through SAPs recommended in P1.

C3.f should include determining whether more FLW is being diverted from landfill and whether more FLW is being dealt with higher up the food recovery hierarchy. It should also include evaluating policy settings, actions, and investments to date to understand effectiveness.

In our previous reports on food rescue, capturing value, and prevention, we also made recommendations that fall under the theme 'Measure and monitor', but are not affected by subsequent recommendations.

P3: Support the creation and adoption of a data platform for the sector.

Next 12 months	By 2027-2028	By 2030
a) Undertake engagement with relevant stakeholders to identify: **i.** functional needs of the data platform; and **ii.** adoption and implementation support needs. **b)** Scope project requirements, taking into account findings from P3.a but also FLW and other goals, and existing technical capabilities and gaps. **c)** Identify options to support platform creation (e.g. direct commissioning, public private partnerships, support for adapting existing private sector solutions, etc.).	**d)** Pilot data platform. **e)** Design and implement a monitoring and evaluation plan for the platform. **f)** Design mechanisms to incorporate relevant advances in digital technology as appropriate.	**g)** Fully roll out platform to all businesses in the New Zealand food supply chain.

Considerations

P3 is related to **S2** but is distinct: **S2** captures data on FLW for monitoring, while **P3** enables collaboration and data sharing across the supply chain to facilitate, for example, logistics and demand forecasting as well as a clearing house that could benefit upcycling and food rescue operations. **P3** could facilitate **S2**.

P3 is consistent with a 2024 report from the Parliamentary Commissioner for the Environment on resource use and waste generation, which recommends "establish[ing] a formal set of material flow accounts for New Zealand".

P3 could be a workstream across central Government, to include Stats NZ, MBIE, and MPI and others. The EU's data platform programme may provide a model to follow. Locally, initiatives like the Trust Alliance New Zealand's Digital Farm Wallet or Stats NZ's accounting system that includes 'satellite accounts', could be scaled up or integrated into the platform.

Theme 3: Prevent food loss and waste at source

Preventing food loss and waste at the source has scope to deliver the greatest environmental, social, and economic benefits throughout the food system, and everyone has a role to play. A high degree of connectivity means that New Zealanders can contribute to food loss and waste prevention not just at their stage of the food supply chain, but throughout the system.

P4: Encourage novel and emergent models of food purchase by consumers.

Next 12 months	By 2027-2028	By 2030
a) Undertake scoping of models for consumer purchase outside of major supermarkets (e.g. refilleries, consumer supported agriculture, and farmers' markets) that for example can enable purchase of only desired quantities. **b)** Undertake or commission evaluation and/or evidence synthesis on the effects of these models on FLW.	**c)** Receive and report findings from **P4.b.** **d)** Informed by **P4.c**, consider mechanisms to promote a diversity of food purchase models.	

Considerations

As is explored in section 3.3, concentrated market power is a potential driver for FLW. Therefore, promoting alternative purchasing models could help reduce FLW.

This work could be led by the Commerce Commission in collaboration with MBIE as it would fit within their remit for increasing competition in the grocery sector.

P5: Identify mechanisms to avoid food loss and waste caused by extreme weather events.

Next 12 months	By 2027-2028	By 2030
a) Commission research to understand the food loss implications of predicted increases in extreme weather events. **b)** Use the results of **P5.a** to identify and develop interventions to prevent waste during extreme weather events.	**c)** Implement actions identified in **P5.b**.	
Considerations Extreme weather and other disruptions bring into play other tiers of the hierarchy as well. See our report *Food Rescue in 2022: Where to from here?* that includes Foodbank New Zealand, and this report.		

P6: Update specification practices that lead to edible food being discarded.

Next 12 months	By 2027-2028	By 2030
a) Explore best practice for consumer communications to make blemished products more acceptable to consumers. **b)** Support stakeholder groups working in this space to evaluate FLW outcomes. **c)** Explore mechanisms to incentivise relevant stakeholders to reform specifications practices and undertake a review of best practice for specifications.	**d)** Support businesses to undertake consumer communications. **e)** Implement relevant mechanisms suggested by **P6.c**.	
Considerations **P6.a** would be part of **P9.b**. **P6.d** and **P6.e** could be piloted on selected businesses or sectors before being rolled out in full.		

Specifications cover appearance, taste and texture, and food safety. Taste and texture and food safety criteria are relatively fixed while appearance (size, shape, and colour) criteria are more dynamic. This recommendation is focused on the more dynamic criteria.

This recommendation will interact with recommendation P8, which promotes technological advances leading to more produce being 'in spec' and recommendation P3, which promotes all supply chain actors having access to demand forecast information.

P6 is in line with recommendations made in EFWA's Horticulture SAP. Consider replicating activities recommended in 'Action P3' of the aforementioned report.

The application of quality standards in export industries (e.g. kiwifruit), which protects the economic wellbeing of producers may have lessons for domestic markets.

P7: Continue to explore improvements to current date labelling.

Next 12 months	By 2027-2028	By 2030
a) Commission or undertake work that explores: **i.** alternatives to current requirements, including standardisation of label formatting; **ii.** the likely implications of different alternatives for waste; **iii.** the likely implications of different alternatives for food safety; **iv.** stakeholder views on uses of date labels; and **v.** evaluate the evidence base on the efficacy of consumer education programme around date labelling.	**b)** Support retailers to pilot, evaluate, and refine potential new labelling approaches, ensuring evaluation includes effect on FLW reduction. **c)** Informed by **P7.a** and **P7.b**, phase in new education and/or labelling approach.	

Considerations

There would need to be coordination with Australia if Food Standards Australia New Zealand leads this work.

Successful examples of date label reform are detailed in table 8 of *Preventing food loss and waste in Aotearoa New Zealand: Evidence from across the supply chain*.

A comprehensive review of international best practice for date label reform, building on table 8 in *Preventing food loss and waste in Aotearoa New Zealand: Evidence from across the supply chain*, would be a good first step. Note that EFWA have a current project reviewing date labelling and food storage advice. Industry as well as consumer perspectives would need to be considered.

P7.b could involve supporting an interested national retailer to undertake a pilot.

Label reform could include messaging around date labelling. The 'Look, smell, taste, don't waste' campaign in the UK may be a good example, and Aotearoa could build on New Zealand Food Safety's 2023 campaign 'Check it, sniff it, taste it, don't waste it'.

P7 would be part of **P9.b**.

P9: Support evidence-based consumer communications campaigns.

Next 12 months	By 2027-2028	By 2030
a) Scope existing work on consumer communications on FLW to identify: **i.** mechanisms to ensure their continuity and; **ii.** gaps where additional work is needed. **b)** Identify new and planned activities that would benefit from consumer communications campaigns on FLW. **c)** Incentivise robust evaluation of activities in this space.	**d)** Use evaluation findings to prioritise ongoing support.	

Considerations

P9.a should capture both national third sector campaigns like 'Love Food Hate Waste' as well as actions taken in the private sector, for example, messaging in retail settings.

P9.a.ii should consider not only specific topics or issues, but also the geography of the campaign (local vs national) and the demographics targeted.

Activities captured under **P9.b** would include **P6** (date labelling) and **P7** (quality specifications).

To achieve **P9.c**, funding could be contingent on having robust evaluation mechanisms embedded.

Theme 4: Save good food for people

Good food is not a waste stream to be managed – it is a resource for nourishing people. Surplus food, imperfect but nutritious produce, and edible by-products are examples of food, not food loss or waste. Resources, systems, and enabling conditions that promote food rescue and upcycling are crucial to ensuring edible food is never treated as loss or waste. If nourishing people is not practical, using the food as feed resources for animals is the next best alternative.

R4: Stop surplus food from being managed lower in the food recovery hierarchy by empowering donors and the rescue sector to redistribute surplus food to people, while noting that source prevention of surplus food is the priority intervention.

Next 12 months	By 2025	By 2030
a) Review the outcomes of the temporary tax exemption for trading stock donation and consider extending it indefinitely for surplus food.*	**i)** Clarify section 352 of the *Food Act 2014*. MPI could consider: **i.** providing an authoritative interpretation of section 352, which addresses existing ambiguities around the safety and suitability of donated food; **ii.** if required in the light of **R4i.i**, updating and strengthening section 352 so that it still applies if not-for-profit recipients charge a fee for the food they upcycle and/or distribute; and **iii.** undertaking outreach to donors and food rescue organisations to ensure the legal context relating to food rescue is understood.	**n)** Review the need for increased or decreased food rescue incentives in the light of progress to address the root causes of food insecurity and surplus food (see **R1.c**).
b) Continue exploring feasible models and circumstances for the recovery and processing of culled wild animals for use in the rescue sector, alongside existing work on commercial opportunities.		
c) Ensure that credit stock arrangements and other aspects of relationships between food suppliers and retailers or other customers don't block the donation of surplus food and give recognition to the correct party.		
d) Empower gleaners and/or primary producers to harvest surplus produce at risk of going to waste for donation to the food rescue sector.		
e) Scope options to resource the rescue sector in a balanced and sustainable way that fosters sector collaboration so that	**j)** Investigate whether the absence of a liability protection clause for donors operating exclusively under the *Animal Products Act 1999* serves as a barrier to	

Next 12 months	By 2025	By 2030
the sector's capacity doesn't constrain the amount of food that can be rescued. A range of models could be considered. This recommendation builds on **R2.b**. **f)** Pilot a fee for service food rescue model to test its feasibility in the New Zealand context and identify factors that would be required for it to be a suitable model. **g)** Support surplus food donors to adopt technological enablers of effective donation. See also **R3.c**. **h)** Implement measures to reduce the amount of food wasted during the process of food rescue.	donation and amend the legislation if it does. **k)** Investigate the development of food rescue-specific tax incentives, drawing on international insights. **l)** Review the impact of waste levy changes and other developments in the waste management landscape on the feasibility of a roll out of fee for service food rescue, building on the pilot work in **R4.f**. **m)** Support the personal and professional development of paid staff and volunteers in food rescue organisations. See also **R5.e**.	

Considerations

*Since **R4** was originally published in *Food Rescue in 2022: Where to from here?*, **R4.a** has been implemented by Inland Revenue and there is now permanent tax relief for businesses donating food (including rescued food). **R4.a** could be supported by outreach to ensure the tax exemption is understood by donors and prospective donors.

See table 3 for more detailed list of opportunities for the food rescue sector.

R4.d could be supported by an exploration of funding models, resourcing gleaners, and incentivising primary producer engagement, building on international best practice. See also **R4.k**.

R4.f could include consideration of an accreditation system that enables food rescue organisations to issue receipts.

R4.h could be supported by data gathered by AFRA on the volume of FLW handled by food rescue organisations, supplemented by research looking at waste resulting from food rescue organisations refusing food from donors as well as the amount of distributed food that is subsequently wasted once it reaches recipient organisations and individuals. It could also look at the volume of food waste associated with managed and unmanaged community pantries and fridges.

R4.i.ii will reduce the risk of food rescue organisations experiencing reduced donation volumes if they transition to social enterprise models.

R4.k could consider providing tax incentives not just for the donation of surplus food, but also for the cost of logistics associated with getting rescued food from donors to recipients. R4.k could also include consideration of GST rules that prevent food rescue organisations from claiming GST on expenses relating to GST-exempt food donations, and whether this is a barrier to sustainable food rescue operations.

We considered recommendations relating to the inclusion of rescue organisations in the Emissions Trading Scheme (ETS) as earners of New Zealand Units but opted not to include this because it doesn't align with the structure and purpose of the ETS. A standard for inclusion of food rescue in voluntary carbon markets has recently been developed, which could be explored for use by donors and/or food rescue organisations.

C9 recommends a ban of FLW to landfill. A well-resourced food rescue sector would help enable legislative change of this nature.

R5: Support the rescue sector to operate with high food safety standards, protecting recipients and enhancing donor engagement.

Next 12 months	By 2027-2028	By 2030
a) Support AFRA to address guidance grey zones, gaps, and inconsistencies in updates to the AFRA *Food Safety Guide*, including by clarifying guidance relating to food donated by private individuals, catering surplus (in a diverse range of scenarios), recalled and withdrawn products, packaged and unpackaged food (including food with damaged packaging), and homekill and recreational catch. Ensure consistent guidance is followed by donors, rescue organisations, and downstream charities, while allowing for variation depending on operating context. **b)** Undertake research to understand: **i.** current food safety practices, knowledge, and training arrangements within food rescue organisations; and	**e)** Develop accessible and targeted training for food rescue organisation staff, volunteers, and donors. This training should be nationally consistent while allowing for variations depending on rescue model and local context. It should be consistent with the AFRA *Food Safety Guide* and any future food safety guidance for the rescue sector. See also R5.a and R5.c. **f)** Resource the food rescue sector for food safety, including ensuring rescue organisations have fridges, freezers, and refrigerated vehicles and explore expanded provision of community fridges. Emissions should be considered in investment decisions. See also R2.b. **g)** Support the food rescue sector and downstream charities to promote safe	**i)** Review food safety practices in the food rescue sector, making comparisons with international practices.

Next 12 months	By 2027-2028	By 2030
ii. the microbiological safety of rescued food. **c)** Develop guidance for rescue organisations regarding food safety when cooking or otherwise processing rescued food for distribution to recipients. **d)** Scope a labelling system for rescued food, to be applied by donors and/or rescue organisations (e.g. frozen on, use immediately after thawing, reheating instructions, etc.).	food practices among recipients of rescued food. **h)** Explore options to enable meat to enter the regulated meat system more readily (instead of being regarded as homekill or unregulated game), such as investment in local or mobile meat processing facilities.	
Considerations **R5.a** would benefit from a pragmatic approach informed by current practices. While there are some donation categories that carry higher risk or risk that is harder to manage (e.g. home-prepared food), a pragmatic approach would involve acknowledging that these practices do sometimes occur and providing guidance on how to best manage food safety risks. Annex 2 in our report *Food rescue in 2022: Where to from here?* could be used to support this work. Consider resourcing community cooking classes as part of the response to **R5.g**.		

C4: Foster the growth of New Zealand's upcycled food sector, prioritising sustainability, nutrition, and whole food utilisation.

Next 12 months	By 2027-2028	By 2030
a) Consider targeting support for innovation in the food sector through upcycling. **b)** Identify mechanisms to prioritise nutrition outcomes alongside outcomes in the development of New Zealand's upcycling sector.	**d)** Work with manufacturers to adopt an upcycling certification scheme so that the term 'upcycled' can be trusted by consumers to indicate a product is combatting FLW and providing environmental benefit.	**e)** Have an established network linking food producers and manufacturers with unused by-products with processors that upcycle these products, replacing use of virgin materials and reflecting upcycling international best practice.

Next 12 months	By 2027-2028	By 2030
c) Undertake or commission work to identify opportunities for upcycled product development in Aotearoa.		

Considerations

Recommendation **C4.c** could build on Central Otago District Council's exploration of upcycling opportunities for fruit producers in the region and could take methodological inspiration from the Plant & Food Research led project mapping animal feed opportunities as well as employing various specialised consumer research techniques to ensure marketability. This activity would also fulfil part of data needs recommended in **S2** and could be facilitated by **P3**.

Recommendation **C4.d** could be pursued through the *Fair Trading Act*, Food Standards Australia New Zealand (FSANZ) food claims regulations, the Upcycled Food Association's certification, and/or sustainability claims work being undertaken by Codex Alimentarius. If an upcycling certification or similar is adopted, future work could explore the utility of expanding it beyond human food products (e.g. to animal feed and materials).

Updated resources have been published in section 2.4, which further evidence best practice in this sector.

Theme 5: Capture value from unavoidable food loss and waste

There will always be some loss and waste in our food system, which must be managed to capture value in alignment with circular economy thinking and the food recovery hierarchy. Diversion to animal feed and investment in material, nutrient, and energy recovery from food loss and waste will ensure there are decent end-of-life options for unavoidable food loss and waste. Landfilling food loss and waste has no place in our waste management future.

R6: Support the rescue sector to manage any food loss and waste associated with its activities according to the food recovery hierarchy.

Next 12 months	By 2027-2028	By 2030
a) Ensure that food rescue organisations have access to FLW management solutions, which are consistent with the food recovery hierarchy, for the management of any incidental loss or waste occurring through their activities.		
Considerations For R6.a, where FLW management comes at a cost and can be attributed to donor practices (e.g. donating food that is unsafe or unsuitable for human consumption, or doesn't have a sufficient shelf life buffer), mechanisms for returning donated food or enabling donors to cover the costs of managing that FLW could be considered.		

C5: Work to replace purpose-produced and imported animal feed ingredients with FLW, particularly utilising food system by-products and post-consumer food loss and waste, without compromising feed safety and animal nutrition.

Next 12 months	By 2027-2028	By 2030
a) Support existing efforts to develop a picture of the FLW – to animal feed opportunity in Aotearoa. **b)** As part of C5.a, evaluate the degree of compliance with FLW – to animal feed regulations, particularly post-consumer food waste feeding practices.	**c)** Clarify the regulatory status of insect bioconversion as a process for converting FLW – to animal feed, considering a wide variety of vegetal- and meat-containing waste streams. See also C5.d.	**d)** Evaluate processing techniques that can render FLW streams microbiologically safe for animal consumption, looking beyond heat treatment and giving consideration to the risk of prions.

Considerations
Since **C5** was first published in the report *Beyond the bin: Capturing value from food loss and food waste*, MPI has been reviewing *Biosecurity (Meat and Food Waste for Pigs) Regulations 2005* as part of the risk analysis for prevention of foot and mouth disease infection and spread via FLW feeding. Efforts towards **C5.a** have already begun (e.g. Plant & Food Research led project, University of Canterbury research). This work could be built on and expanded, including an exploration of FLW utilisation in cellular agriculture. Recommendation **C5.c** could also cover non-FLW streams such as biosolids and manure and could also cover insect bioconversion for human food. This work could draw on the European Food Safety Authority's 2015 risk profile related to production and consumption of insects as food and feed and more recent literature. Recommendation **C5.c** could take place within a broader programme of work related to recommendation **C5.d**. Findings produced from recommendation **C5.d** could be used to inform a review of the regulations governing animal feed in Aotearoa, such as the *Biosecurity (Ruminant Protein) Regulations 1999* and the *Biosecurity (Meat and Food Waste for Pigs) Regulations 2005*. Pilot projects in specific regions for new approaches to FLW – to animal feed processes could help ensure efficacy of interventions before nationwide roll out.

C6: Support material recovery efforts for food loss and waste streams that are inedible and can't readily be prevented at source.

Next 12 months	By 2027-2028	By 2030
a) Support material recovery research and development collaborations between industry and researchers (e.g. the Bioresource Processing Alliance).	**b)** Ensure that any biobased products and packaging produced through material recovery efforts are developed in alignment with guidance from key Government stakeholders like MfE, industry stakeholders (e.g. New Zealand composters), and relevant international standards.	
Considerations Recommendations **C6.a** and **C6.b** could be mediated through the Bioresource Processing Alliance (BPA) and SFF Futures Fund.		

At time of writing, relevant guidance for recommendation **C6.b** included MfE's position statement on compostable products and the New Zealand Composters' position statement on compostable packaging; relevant documents will change over time. Implementing recommendation **C6.b** will help facilitate nutrient recovery efforts.

C7: Ensure that processes and pathways are in place to enable nutrients from unprevented food loss and waste to be safely returned to the environment via productive land, parks, and gardens, aligning with MfE's Waste Strategy.

Next 12 months	By 2027-2028	By 2030
a) Support existing work to develop and implement guidelines for the beneficial use of organic materials on productive land. This could include: **i.** ensuring that voluntary standards are adopting best practice from overseas before mandating locally; **ii.** supporting regular updates, including future expansion of scope (e.g. to include insect frass, a wider range of contaminants, applications beyond productive land, te ao Māori insights and considerations); **iii.** supporting the development of industry-led technical guidelines; **iv.** clarifying the relationship between the organic materials guidelines and synthetic fertiliser regulations; **v.** supporting the development of the nutrient recovery workforce, building the people skills required to meet the guidelines; and **vi.** exploring the need for complementary efforts to manage	**d)** Commission independent research to evaluate the growth/productivity benefits of different FLW-derived soil amendments and biofertilisers. Soil amendments should be compared against one another and against synthetic fertiliser, in the New Zealand context, building on international insights. **e)** Seek independent review of industry-led guidelines for digestate production and application to land. **f)** Review and update compost standard (NZS 4454:2005) to reflect different waste streams, with potential to make compost standards/grading mandatory. **g)** Explore a nitrogen cap for non-synthetic sources of nitrogen.	**h)** Design an evaluation of diversion and contamination rates from kerbside food waste collection services, and where rollout is well established, implement the evaluation and use insights to inform continuous improvement. **i)** Evaluate key sources of macro- and micro-contaminants in nutrient recovery products and continuously work to reduce their introduction through feedstocks. Mechanisms for contaminant reduction could include: **i.** education and communication campaigns; **ii.** penalties for introduction of macro-contaminants and; **iii.** product regulations or bans (e.g. relating to compostable products, use of plastic in tea bags, herbicides).

Next 12 months	By 2027-2028	By 2030
the inputs to nutrient recovery processes (see **C7.g**). **b)** Embrace social procurement principles and value place-based solutions when developing FLW collection and processing. **c)** Continue to support home-based nutrient recovery (e.g. via home compost bins, worm farms, and bokashi bins).		

Considerations

Recommendation **C7.a** relates to the 2017 draft guidelines for beneficial use of organic materials on productive land (developed by the waste sector in partnership with MfE, MoH, and MPI), New Zealand's voluntary compost standard in Aotearoa (NZS 4454), the *Organic Products and Production Act 2023*, and the Hua Parakore verification scheme, and the recent work on contaminants in organic waste published by MfE. Relevant agencies include MfE and MPI, as well as territorial authorities. Contaminants that could be considered under **C7.a.ii** include microplastics, per- and poly-fluoroalkyl substances (PFAS), and herbicides.

Recommendation **C7.b** could be linked to wider community resilience, community building, and sustainability education initiatives. It could be implemented through initiatives such as reserving a set proportion of households and/or businesses for community-based providers, and/or requiring industrial providers to work with community partners.

C7.d could include ploughing unharvested food back into soil, or this could be the subject of a separate piece of research.

The findings from recommendation **C7.d** could help inform lifecycle assessment work looking at the lifecycle impacts (including emissions) of nutrient recovery solutions, factoring in the impacts of potential synthetic fertiliser displacement. The results could also be used to build end market confidence in soil amendments and provide an evidence base for effective integration into agricultural systems. Aspects of the New Zealand context of relevance to this work include soil types, agricultural systems, and soil amendment (and synthetic fertiliser) application practices, regulations, and guidelines.

C8: Explore the potential for solutions to unprevented food loss and waste to supplement natural gas supplies.

Next 12 months	By 2027-2028	By 2030
a) Develop a guide for investment in infrastructure, which sets out a position on different technology types and where investment/efforts should be focused.	**b)** Enable energy recovery from FLW to displace virgin natural gas.	
Considerations Recommendation **C8.a** would consider the viability and implications of all sources of feedstock including food. The guide may need periodic updating as new technologies emerge or existing technologies improve. Successful implementation of recommendation **C8.b** would require biogas derived from FLW streams to be the same price, or cheaper, than virgin natural gas. Industry estimates suggest that FLW derived biogas could displace 1.5% of virgin natural gas, or 0.3% of our total energy consumption. **C1.d** could be done in conjunction with **C8.a**.		

C9: Explore the merits of banning food loss and waste from landfill

Next 12 months	By 2027-2028	By 2030
a) Continue to clearly signal the intention to ban FLW from landfill by 2030.*	**b)** Scope options for the implementation of a FLW disposal ban, including considerations to avoid FLW dumping, options for FLW management in the face of unexpected events, the level at which the ban should be enforced (e.g. waste producer and/or waste processor), and the mechanism of enforcement.	**d)** Evaluate New Zealand's readiness to implement a ban on FLW from landfill.

Next 12 months	By 2027-2028	By 2030
	c) Make it easy for FLW 'owners' to find alternatives to disposal. This could include: **i.** mapping out available valorisation options at a variety of scales (see C3); and **ii.** support for FLW brokering providers and platforms.	

Considerations

*MfE has already signalled the intention to ban organics to landfill by 2030 (in the Emissions Reduction Plan); our recommendation is limited to FLW given the project's scope.

Effective implementation of recommendation **C9** relies on the development of feasible alternatives, as covered in our reports *Beyond the Bin: Capturing value from food loss and waste*, and *Food Rescue in 2022: Where to from here?* as well as FLW prevention interventions. Uptake of **R4** would support effective implementation of **C9**.

C9.a will allow for stakeholder buy in to be part of working towards this target.

The Emissions Reduction Plan signalled an intention to require landfills to have gas capture systems in place by 2026.

Implementing **C9.c.i** could expand efforts at Manaaki Whenua | Landcare Research to survey and map out community-scale composting clubs and social enterprises, or work done on MfE's 2021 infrastructure stocktake, to include upcycling, animal feed, and material recovery businesses.

A ban could be piloted as a case study in local government areas to evaluate efficacy and identify sticking points before being rolled out nationally.

1 Combatting food loss and waste: A summary

An estimated 40% of food produced for human consumption is lost or wasted globally, amounting to 2.5 billion tonnes per year.[1] In 2015, UN members set 17 Sustainable Development Goals (SDG). SDG 12.3 pertains specifically to food loss and waste (FLW), targeting a 50% reduction of food waste at retail and consumer levels, and a reduction of food loss in production and processing, including post-harvest losses, by 2030.[2] The title of this report reflects a more ambitious goal, to halve FLW. Combatting FLW in Aotearoa is important because of the environmental, social, and economic harms associated with it.

Combatting FLW in Aotearoa is important because of the environmental, social, and economic harms associated with it.

- Wasting food means accruing all the environmental harms and expending unnecessary volumes of the often limited resources associated with food systems without realising the benefits of nourishing the growing global population. Land and water use, soil and water contamination, energy use, and greenhouse gas emissions, including methane, throughout the food lifecycle and during decomposition are among the environmental costs.[1]
- From a social perspective, wasting quality surplus food represents a missed opportunity to nourish people, which is particularly problematic given the number of people experiencing food insecurity globally and in New Zealand.[3]
- It takes financial resources to produce, process, manufacture, distribute, store, market, buy, and prepare food, so when food is wasted, people throughout the food system stand to lose economically.[4] The financial costs of FLW may be buried, transferred, or unidentified by players in the food system, but are nonetheless real.

1.1 Defining food loss and waste

FLW is surprisingly difficult to define, lacking an internationally consistent definition. The chief complexities arise from deciding which stages of the food supply chain to include, whether to include both edible and inedible components of food, and which end destinations to count as 'waste.'[3,5-11] This lack of definitional uniformity extends to related concepts, including food loss, surplus food, agricultural waste, and even food itself.[6] The Ministry for the Environment (MfE), in collaboration with New Zealand Food Waste Champions 12.3 (NZFWC) established a national definition for FLW in 2023, which is as follows;

> *"Imported or domestically produced food and drink, including inedible parts, which leave the food supply chain from the point that crops and livestock are ready for harvest or slaughter onwards to the point of consumption, to be recycled, recovered or disposed of in Aotearoa New Zealand."*

As shown in figure 1, the definition also distinguishes between 'food waste' and 'food loss' according to where it leaves the supply chain.[12]

Figure 1: Food loss and food waste within the food supply chain, as per MfE's definition. Image credit: MfE.[12] Food loss occurs at the production, processing, and manufacturing stages, while food waste is when food exits the supply chain anywhere from the retail stage to consumption.

As is often the case when creating specific definitions for complex phenomena such as FLW, there are trade-offs that arise from where these lines have been drawn. The term 'waste' itself can be an emotive word because of a perceived moral judgement that is often attributed when using it.[13] It feels unfair, for example, to tell a grower they are 'wasting food' because they don't harvest the crops they cannot sell, when harvesting such crops would require an investment of further resources only for that product to be lost or wasted further down the supply chain.[14] Nevertheless, this practice, under MfE's official definition, constitutes food loss. However, as is discussed in section 1.2, it is important to contextualise this with the evidence that root causes of FLW are not necessarily located where FLW is realised.

In many contexts FLW is instead referred to as 'surplus food', 'food by-products' or just a natural part of circular food production. These contested definitions of 'waste' can make it difficult to focus on the best fate for surplus food in each local context. Acknowledging that the optimal fate of FLW can only be determined locally, we nevertheless seek to highlight high level principles, along with likely tensions or trade-offs involved in decision making around FLW. For the purposes of this project, we have taken a broad and inclusive approach to addressing FLW. We aim to inspire source prevention as the primary objective and ensure food and its by-products are used to maximum benefit and minimal harm – which means embracing the food recovery hierarchy and circular economy concepts, where food is viewed as a resource and only thought of as waste when there are genuinely no feasible avenues for its utilisation. Refer to section 2 for more information about the food recovery hierarchy.

…we have taken a broad and inclusive approach to addressing FLW.

1.2 Drivers of food loss and waste

Conventional wisdom suggests that the most FLW, at least in high income countries like New Zealand, comes from consumers discarding food that is still good to eat.[15] Businesses are generally incentivised to maximise profits[16] and minimise waste. However, it can also be less costly for individual actors in the food chain to let food exit the chain than to keep it in. For example, growers

may find it more profitable not to flood the market with a crop that is in season, which might lower the price. Similarly, a retailer might incentivise customers to buy more food than they need or can consume. For this reason, we can't rely on the notion that businesses will always strive to reduce FLW. This is especially apparent in production, where, for example, labour costs to harvest produce can be up to two thirds of all input costs, making it economically unviable to harvest crops that won't attract full price.[17]

In Australia, 32% of FLW happens in households.[18] A narrow focus on consumers, neglecting the other parts of the supply chain, can only ever address part of the problem. This approach also suggests that individual consumers are responsible for FLW, when they have much less influence than large commercial actors. Nonetheless, collective consumer awareness and purchasing power can drive change. We discuss consumers in detail in section 6 of our report *Preventing food loss and waste In Aotearoa New Zealand: Evidence for action across the supply chain*.

…collective consumer awareness and purchasing power can drive change.

The root causes of FLW are often complex and inter-related and in a different part of the supply chain to where FLW occurs.[19] While many drivers for FLW are context specific, distinct parts of the supply chain may be bound together and subject to many of the same challenges, including extreme weather, inadequate infrastructure, and labour shortages.

Specific drivers are discussed throughout this report and the report series where they arise, but below are some examples of complex inter-related drivers for FLW across the supply chain.

1.2.1 Overproduction

A key driver of FLW across supply chains in high income countries like Aotearoa is overproduction, that is, more food being produced than will ultimately be consumed or exported. Some overproduction arises from difficulty in accurately anticipating the amount of food needed.[20,21] Much of this overproduction, however, is caused by trade arrangements that incentivise overproduction as a risk avoidance mechanism.[22,23] Commonly, terms of trade contracts allow customers, such as major retailers, to exert their greater power so that a supplier's failure to supply enough product would be costly to the supplier – who also bears the costs of overproduction. This is further explored in the report *Preventing food loss and waste In Aotearoa New Zealand: Evidence for action across the supply chain.*

1.2.2 Logistics and handling

Significant planning is needed for food to move from production along the supply chain to where it is consumed. Among the considerations are:

- suitable transport and storage available at the right times;
- components of a manufactured product or a food service menu are available at the same time;
- coordinating the use of machinery used for multiple products; and
- optimising stock levels.

A 2021 literature review identified 49 studies that described logistics-related drivers of FLW across five categories: transport, warehousing, inventory management, packaging, and communication.[24] Examples include: rough handling of products leading to physical damage and making products more vulnerable to deterioration; storage at the wrong temperature leading to either physical damage or

risk of food safety issues; and storage and inventory management decisions that shorten items' shelf life or do not make them available to move along the chain within their shelf life.[19] There is also a significant amount of decision making that occurs throughout the supply chain, much of which could affect whether food is ultimately lost or wasted, or where along the food recovery hierarchy it ends up (see section 2). How these decisions are made and whether they consider FLW is both a potential driver for FLW and an opportunity to prevent it. Specific examples are explored in each of the reports in our food waste series.

How these decisions [about supply chain logistics] are made and whether they consider FLW is both a potential driver for FLW and an opportunity to prevent it.

1.2.3 Specifications

Food must meet quality specifications to progress along the supply chain. Some of these specifications relate to food safety and nutrition and ensure the health and wellbeing of consumers. However, particularly for fresh produce, some of these specifications are purely cosmetic and result in edible, nutritious food being lost. These are set based on market research of consumer preferences in the target market. Research on children's perspectives on 'ugly' fruit and vegetables, however, suggests that these preferences are learned and therefore malleable.[25] Anecdotal evidence from those in the industry suggests these specifications are flexible depending on the supply and demand conditions.[17] Revising specifications and widening the scope for marketable produce requires addressing drivers at both ends of the supply chain. Where export products are concerned, this can be more difficult because consumers are spread globally and are potentially harder to influence. There may be a tension between creating secondary markets for these products, for example Woolworth's 'Odd Bunch' range,[26] or produce delivery scheme 'Wonky Box',[27] versus widening the scope of mainstream supply. Other specifications pertaining to the quality or safety of food have more impactful considerations and are much less flexible than purely cosmetic specifications, but secondary markets could still be a viable alternative for lower quality products. Specifications are explored further in section 2.1.2 in our report *Preventing food loss and waste In Aotearoa New Zealand: Evidence for action across the supply chain*.

1.3 In Aotearoa

While New Zealand is both an importer and exporter of food, it is food exports that dominate our economy and it seems likely that food export will remain an important pillar of our economy for the medium to long term.[28] An estimated 80-90% of food we produce is exported; in 2023, food accounted for 68% of all export earnings, with a combined revenue of $48 billion.[29] Despite producing enough calories to feed an estimated 20 million people,[30] 21.3% of children live in households reporting that food runs out sometimes or often, with Māori and Pacific peoples disproportionately affected.[31] The distance between producers and consumers of food produced in Aotearoa also introduces uncertainties of supply and demand and economic drivers of FLW not present in countries where most food is produced for local consumption.[3,32]

Despite producing enough calories to feed an estimated 20 million people, 21.3% of children live in households reporting that food runs out sometimes or often, with Māori and Pacific peoples disproportionately affected.

Initiatives combatting FLW are already underway in New Zealand, enacted by a range of stakeholders including government, industry, research entities, and community and advocacy organisations. Many of these are detailed throughout the report series. As is illustrated in figure 3, some of these relate to specific parts of the food supply chain or food recovery hierarchy, while others take a whole supply chain or system change approach.

The distance between producers and consumers of food produced in New Zealand also introduces uncertainties of supply and demand…

MfE is the Government agency most focused on FLW reduction, with the Ministry of Primary Industries (MPI) and the Ministry for Social Development (MSD) also playing key roles. The Environment Committee's food waste briefing completed in 2020 recommended a 'target, measure, act' approach.[33] MfE's response[34] has included establishing a national definition[12] and commissioning the University of Otago (UoO) to conduct a national baseline measurement study for FLW, which will be completed in 2024. They also have a suite of national food waste reduction programmes, contributing a total of approximately $4.6 million to behaviour change programmes in businesses, households, and Māori-led settings. These programmes are funded by climate emergency response funding.[35]

Table 1 shows a list of Government initiatives including legislation and regulation, reports and strategies, funding mechanisms, and programmes and activities relating to FLW. More detail about these initiatives and how they relate to FLW specifically can be found in annex 2 of our report *Food waste: A global and local problem*. Section 3 of this report goes into further detail about Government and non-government stakeholders and their place in the FLW ecosystem, illustrated by an ecosystem map recently published by NZFWC (see figure 3).

While FLW is already being addressed by several Government agencies in multiple ways, the distribution of initiatives across agencies presents challenges relating to funding, responsibility, accountability, and cohesion. Key opportunities to create a more strategically aligned policy landscape are discussed in section 4 of this report.

Table 1: Local and Central Government initiatives, as well as multinational initiatives that New Zealand Local and Central Governments are involved with, relating to FLW. Abbreviations: APEC = Asia-Pacific Economic Cooperation, BPA = Bioresource Processing Alliance, COP28 = UN 28th Conference of the Parties, FAO = Food and Agriculture Organisation of the UN, FLW = food loss and waste, IRD = Inland Revenue Department, MBIE = Ministry for Business, Innovation and Employment, MoE = Ministry of Education, MfE = Ministry for the Environment, MoH = Ministry of Health, MPI = Ministry of Primary Industries, MSD = Ministry of Social Development, SDG = UN Sustainable Development Goal, UNEP = UN Environment Programme.

Who	**Initiatives relating to food loss and waste**
MBIE	• Grocery Supply Code.[36] • BPA.[37] • National Science Challenges.[38]
MfE	• Environment Committee food waste briefing[33] and Government response.[34] • National definition for FLW.[12] • National baseline measurement study for FLW (forthcoming in 2024). • National food waste reduction programmes.[39] • Transforming recycling consultation 2022.[40] • Standard Materials for Kerbside Collections Notice 2023.[41] • Emissions Reduction Plan.[42] • *Climate Change Response (Zero Carbon) Amendment Act 2019*.[43] • Aotearoa New Zealand Waste Strategy (2023).[44] • Waste disposal levy.[45] • *Waste Minimisation Act 2008*.[46] • Waste Minimisation Fund.[47]
MoE	• Ka Ora, Ka Ako (healthy school lunches programme).[48]
MoH	• 2008/9 Nutrition Survey.[49]
MPI	• Australia New Zealand Food Standards Code.[50] • *Fisheries Act 1996*.[51] • *Food Act 2014*.[52] • Legislation relating to animal feed.[53-55] • Sustainable Food and Fiber Futures Fund.[56] • Fit for a Better World roadmap.[57] • NZ Food Safety Strategy.[58]
MSD	• Food Secure Communities programme.[59]
IRD	• Tax relief for businesses donating food (including rescued food).[60]
Territorial authorities	• 'Love Food Hate Waste'.[61] • Kerbside organics collections.[62-64] • FLW targets.[65] • Central Otago District Council fruit loss potential project.[66] • Other waste minimisation activities through the waste disposal levy.[45]
Treasury	• Climate Emergency Response Fund (reducing emissions from waste, diverting organic waste from landfill).[35]
Interagency	• Sustainable food systems project.[67] • Cross-agency food systems group.[67] • Mana Kai Initiative[68]
Multinational	• COP28 Declaration on food and agriculture.[69] • Global Methane Pledge.[70] • Paris Agreement.[71] • Codex Alimentarius International Food Standards.[72,73] • APEC food security roadmap towards 2030.[74] • C40 Cities: Advancing Towards Zero Waste Declaration (Auckland).[75] • FAO Food Loss Index.[2] • SDG 12.3.[2] • UNEP Food Waste Index.[76]

2 Understanding food loss and waste

2.1 Guiding frameworks

Our recommendations were guided by a set of frameworks and principles in line with international best practice as well as considerations specific to the New Zealand context. These are set out in the *Project Framework* and expanded on in the first report *Food waste: A global and local problem* and include:

The food recovery hierarchy

This framework (see figure 2) aims to prioritise action to prevent, divert, and manage FLW according to their ability to deliver on environmental, economic, and social outcomes.[6,77] Our previous reports *Food rescue in 2022: Where to from here?, Beyond the bin: Capturing value from food loss and food waste*, and *Preventing food loss and waste In Aotearoa New Zealand: Evidence for action across the supply chain*, describe many ways to solve some of the problems created by FLW at different levels of the hierarchy. While the food recovery hierarchy is a valuable guide to reducing FLW and its adverse impacts, rigorously adhering to it can have unintended consequences, so it needs to be applied with nuance.[6] The hierarchy does, however, provide a helpful framework for prioritising actions to reduce FLW and its related harms. Insights gathered throughout the project are therefore summarised in this section using the hierarchy as an organising framework.

While the food recovery hierarchy is a valuable guide to reducing FLW and its adverse impacts, rigorously adhering to it can have unintended consequences, so it needs to be applied with nuance.

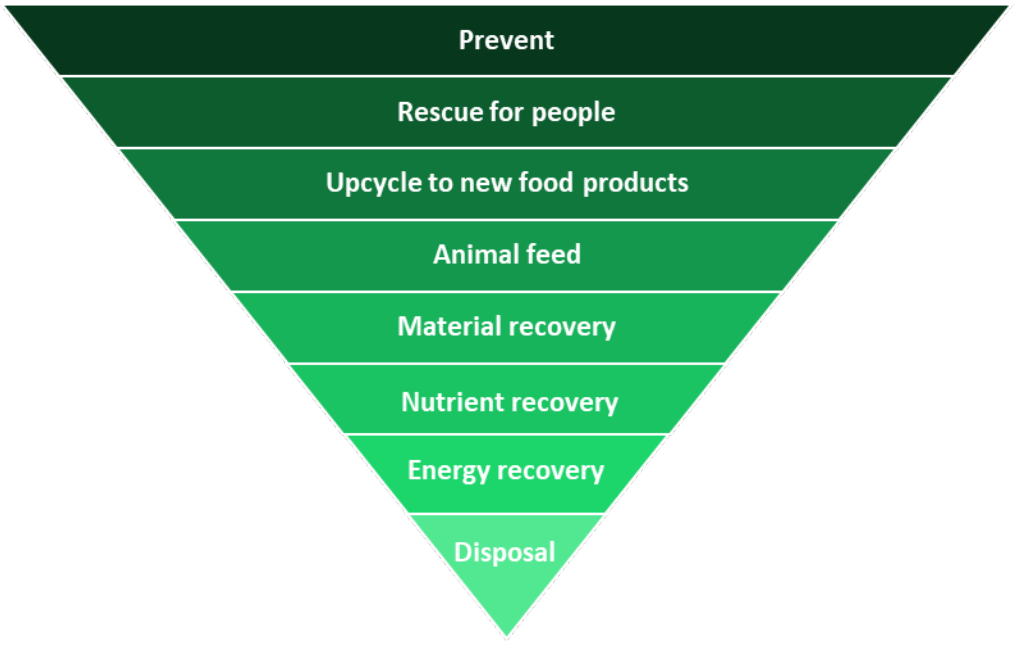

Figure 2: Food recovery hierarchy, modified from Teigiserova et al. and Moshtaghia et al.[6,77]

Circular economy thinking

This framework is underpinned by a shift away from the 'take-make-use-waste' approach to resource use and towards a system where waste is designed out, products and materials are kept in use for as long as possible, and natural systems are regenerated.[78] Circular economy thinking can work alongside the food recovery hierarchy in helping to prioritise FLW action.[b]

Insights from te ao Māori and mātauranga Māori

Long before the development of the food recovery hierarchy and circular economy frameworks, sustainable and regenerative relationships with te taiao have been central to te ao Māori,[79,80] providing insights that are pertinent to combatting FLW in Aotearoa. A relational, holistic, and intergenerational view of environmental stewardship and insights from mātauranga Māori are embraced throughout this project.

2.2 Prevention

When we talk about prevention, we mean any efforts to stop food going to lower levels of the food recovery hierarchy by addressing root causes for FLW.[81] Preventing FLW across all parts of the supply chain is a more effective way to save money and mitigate climate change than simply managing wasted food at the end of its life, because this prevents the unnecessary financial and environmental costs that FLW incurs along the food supply chain as well as the financial and environmental costs of its recovery or disposal.

Scientists, engineers, and entrepreneurs, both at home and abroad, are innovating in ways to prevent FLW. However, some of the drivers for FLW are not amenable to technical improvements, but instead come from the structure of the market and the relationships between different actors across the supply chain.[14] Consumer preferences and habits also play a role.[82] These factors will need addressing alongside any gains we can make through scientific innovation.

…some of the drivers for FLW are not amenable to technical improvements, but instead come from the structure of the market and the relationships between different actors across the supply chain.

At the highest level, we should invest in technical and other solutions that optimise the operations of the supply chain, while also ensuring that the market is set up to incentivise prevention of FLW. Similarly, we can implement prevention measures simultaneously across the supply chain, rather than prioritising a single stage or intervention.

2.2.1 Looking across the whole supply chain

The pathway of food along the supply chain depends – on one hand – on a series of sales or sales-like transactions, and on the other on logistics to physically move the food to the right place at the right time. FLW, then, can not only happen at the discrete stages of the chain, but through problems encountered as it moves along, either in the less tangible background transactions, or in the more tangible logistics. The food supply chain faces challenges in coordination, logistics, and matching supply and demand.[83] Thus, to prevent FLW we need to both focus on individual stages of the food supply chain and take a systems view that considers the chain as a whole. Case study 1, *Preventing food loss and waste In Aotearoa New Zealand: Evidence for action across the supply chain*,

[b] The idea that circular economy thinking can work alongside the food recovery hierarchy is further explained in section 1.7 of our previous report *Beyond the bin: Capturing value from food loss and waste*.

demonstrates the complex dynamics of food supply chains through using the example of a tomato supply chain.

Without a whole supply chain view, there is a risk that prevention efforts push FLW to other parts of the supply chain that are out of view of individual sectors, rather than preventing FLW across the system.[84] With a largely export oriented food production sector, the New Zealand context is potentially a particularly challenging setting for maintaining a view of the whole supply chain. This should be a consideration when taking action to prevent FLW in this country.

2.2.2 Production

Production – where food is grown and harvested – is the first stage of the food supply chain. Food loss in production includes produce that is grown for human food use and not harvested, pre-harvest losses, losses through disease and weather impacts, and food rejected on farm because of safety or quality concerns. Out of scope for this report series are crops grown for seed production and crops intended for animal feed. Globally, the production stage has been identified as accounting for approximately 25% of total FLW, the second highest proportion of FLW after households.[1] Currently there is not a comprehensive national estimate for food loss at production for Aotearoa[85] (although a national baseline measurement study is underway) but a recent Australian study, where there is a broadly similar export oriented food production system, shows that this stage is responsible for around 22% of total FLW.[18]

Globally, the production stage has been identified as accounting for 25% of total FLW, the second highest proportion of FLW after households.

Measuring food loss in production

On farm food loss is recognised globally as a significant data gap. This is partly due to the difficulty of accurately measuring food loss on farms because of logistical barriers and the variability between produce.[86] Initial measurements of FLW across the supply chain recognised household food waste as the key hotspot for FLW, but excluded food loss on farms. As this data has become more available, on farm food loss is revealing itself as another hotspot within the supply chain.[87] For example, the National Food Waste Strategy Feasibility Study conducted in Australia in 2021 found on farm food loss to be a FLW hotspot not previously known or addressed by policy.[18] This is of particular concern in New Zealand, because of the size of our food production sector.[85] However, as explained above, we do not have data available to fully understand the extent of food loss on farms in Aotearoa. Facilitating data collection and transparency of in farm food losses should be a priority so that efforts to prevent it can be appropriately implemented and effectively evaluated.

Drivers for food loss in production

FLW that occurs in production has a complex set of interacting drivers that are often outside of the control of producers themselves.[86] Drivers can be divided into five categories:

- Economic factors can cause food loss when it is no longer profitable to harvest food that was grown with the intention of feeding people. Economic factors are affected by trade agreements, fluctuating market prices, and increasing input costs that mean producers often have high levels of economic risk and leads to the practice of overproduction.[22,88]
- Consumer preferences and subsequent cosmetic specifications imposed onto farmers produce by retailers, wholesalers, and packhouses.[89]
- Weather and environmental conditions. For example, droughts, storms, pests and diseases leading to animal casualties,[90] damage to fruits,[89] and crops being destroyed pre-harvest.

- Operational issues such as labour shortages causing food to go unharvested, equipment failures such as power outages causing cooling systems to fail and spoiling food, and infrastructure disruptions that can disrupt transport of food from farm.[c,91]
- Treatment of mastitis in dairy cows with antibiotics causes some dairy production losses on farm, and meat losses occur when animals die on farm due to natural causes or, in the few cases where management of animal welfare necessitates euthanasia.

Current market conditions encourage farmers and growers to practise overproduction as a buffer against uncertainty in the environment (i.e. volatile weather conditions) and markets (i.e. consumer demand and price).[92] However, because farmers are price-takers due to the power dynamics in the food supply chain, farmers are often left to dispose of and accept the risks of dumping food on farms or leaving it unharvested.[14,22]

Farmers and growers that are part of co-operative business models tend to have better negotiating power with stakeholders downstream and may avoid some of the economic driven factors – like volatile and low prices achieved from retailers leading to overproduction – and the subsequent onus to dispose of food on farms.[93,94] When robust quantitative data is available on quantities of food loss on farms, it would be useful to explore how different business structures within the food supply chain affect – positively or negatively – waste outcomes on farm.

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In sectors such as meat and dairy that are dominated by the production of relatively high value commodities for export, scrutiny over farmers environmental and animal welfare practises and stringent export regulations have a significant impact on food loss prevention of dairy and meat.[95-97] In the horticulture sector, produce that is not harvested, for economic or operational issues, or is rejected on farm due to cosmetic specifications, can be recycled by composting or ploughing in to the soil, which improves the soil structure for the next crop.[14]

Initiatives that better integrate supply and demand alignment, enhance competition amongst retailers and wholesalers,[d,98] and drive consumer preferences for 'imperfect' produce would reduce FLW at the production stage. Technologies that reduce the need for labour and improve the quality of produce could also be valuable, but are challenging for agri-tech developers to develop for exclusive use in New Zealand, given the relatively small number of farmers and growers in the New Zealand agricultural sector who could purchase and use these technologies.

2.2.3 Processing and manufacturing

Processing and manufacturing involves creating new ingredients or products that can have a longer shelf life than whole foods.[99] There is scarce FLW data available for this stage in the supply chain in Aotearoa. Drivers of FLW in this part of the supply chain concern either 'unavoidable' loss, or 'avoidable' loss. Unavoidable loss includes loss that is built-in, such as the removal of parts that are not typically used or eaten, otherwise known as by-products (noting that these by-products may still have non-food uses) as well as food removed from the supply chain to carry out quality control

[c] Operational decisions are not always made with food loss in mind and therefore are not always optimised for food loss reduction. This is a systemic issue that needs systemic solutions.
[d] Concentrated market power is evidenced as a driver for FLW across the supply chain. This is further discussed in section 2.2.4.

testing and meet product specifications or terms of trade or financially viable returns. Avoidable FLW occurs due to an error or inefficiency, such as difficulties in planning inventory and matching production with demand[100] as well as machine faults or human errors.[101-103]

A 2021 study in Germany estimated that 10–55% of FLW was preventable during processing.[104] To understand the situation in New Zealand however, more data and information around categories, quantities, and areas of loss are needed. This will help businesses make decisions and optimise processes that reduce food loss, as well as inform more strategic action across the sector.

Increasing efficiencies in manufacturing processes is potentially a key way to reduce food loss in processing and manufacturing. These efficiencies could be achieved in various ways. Exploring alternative business models such as 'lean manufacturing'[105,106] as well as collaborative business practices and data sharing could aid in order prediction, inventory management, and equipment scheduling, and ultimately reduce food loss.[107] For example, digital business to business platform CiRCLR helps companies turn potential waste into new revenue streams for businesses.[108] FLW reduction should also be included as a part of business key performance indicators (KPI) and high level strategy.[109,110]

Technological innovations in food science such as pasteurising and fermenting, as well as packaging technologies can increase the shelf life of foods. Active packaging that reduces microorganisms or maintains the environment the food is in can prevent damage, spoilage, and reduction in quality.[111] Intelligent packaging can also include indicators to provide consumers with more accurate and specific information regarding when food is still safe to eat.[112]

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Digital technology innovations can help prevent FLW within this stage of the supply chain, as well as have an impact both upstream and downstream through interactions with suppliers, distributors, and consumers. Digitalisation of the processing and manufacturing of food through digital twin technology[113] or 'Internet of things'(IoT) for monitoring systems,[114] advanced data systems for planning, scheduling[115] or demand forecasting,[116] radio frequency identification (RFID) tags or 2D barcodes[117,118] for tracking and using digital ledger technologies (e.g. blockchain) for transactions between suppliers and purchasers[29,119] can also be useful to streamline processes and prevent waste.

Policies around FLW measurement and reporting for processors or manufacturers, reviewing the labelling and packaging standards of products to prevent food waste further downstream in the supply chain, as well as resourcing for the adoption of new digital technologies, are key to facilitate the adoption and evaluation of preventative practices by food processing and manufacturing companies.

2.2.4 Retail and food service

Retail and food service sectors are uniquely positioned in the food supply chain, interacting directly with consumers and suppliers of food. As such, we can think about food waste in these sectors in two ways: food waste that occurs within retail and food service sectors; and FLW that occurs up and down the supply chain that is influenced by these sectors. We know little about food waste generated within retail and food service in New Zealand; extrapolation from limited study suggests it's significant, but less than that which occurs in households.[120]

Food waste in the retail sector is driven by a combination of operational inefficiencies like poor demand forecasting and market-driven practices like overstocking.[121] In food service, international evidence suggests that consumer plate waste is the primary driver of food waste in the sector, followed by operational inefficiencies like inventory mismanagement.[122]

A range of technical and strategic interventions are available to reduce waste within the sectors, with international evidence highlighting both the success and the challenges of many interventions. In preventing FLW upstream in the supply chain, two key levers are available to retail and food service sectors: addressing cosmetic specifications to reduce on farm losses; and improving ordering practices to limit overproduction.[22] Both of these could be addressed through the Grocery Supply Code (the Code) administered by the Commerce Commission. The Code is intended to promote fairness and competition in the grocery sector and has potential to reduce FLW, but this currently sits outside its remit.[36] The European Commission's directive against unfair practices in the food supply chain[123] and the review of the equivalent legislation in Australia: The Australian Food and Grocery Code of Conduct, which includes specific reference to FLW,[124] provide international precedent for incorporating FLW reduction as an objective. Looking downstream, retailers also have a role to play in educating consumers and shaping their expectations to help reduce food waste in-stores and in households.

In preventing FLW upstream in the supply chain, two key levers are available to retail and food service sectors: addressing cosmetic specifications to reduce on farm losses; and improving ordering practices to limit overproduction.

2.2.5 Household

In households, food waste includes any edible and inedible or undesirable parts of food that are bought, received, or harvested and possibly processed or stored, but are not consumed and eventually discarded. A significant amount of FLW across the food supply chain occurs in households. Household food waste in Aotearoa is estimated to account for 40% of total FLW.[125] However, without robust data from other parts of the supply chain, this estimate relies heavily on data inferred from international sources. This figure is based on bin audits in 2015 of household bins. The audits estimated 122,547 tonnes of food waste is generated by households each year, the equivalent of $872 million of edible food.[126] A further study in 2018 estimated that 54% of household food waste in New Zealand is avoidable.[125] The most wasted food items in New Zealand households are reported to be fresh vegetables, followed by fresh fruit and then meat and fish.[127]

…[an] estimated 122,547 tonnes of food waste is generated by households each year [in NZ], the equivalent of $872 million of edible food.

Drivers for household food waste

Food waste that occurs in households involves a complex interplay of numerous behavioural, environmental, and socio-cultural factors, from the individual and the wider societal level.[128] Individual behaviour related to food waste can be separated as relating to either planning and purchasing, or storage, preparation and leftovers. There are also, however, socio-cultural factors that impact food waste in households.

Firstly, behaviours around planning what to buy and the process of buying food can impact how much of a household's food is wasted. For example, a lack of planning can lead to over stocking, food going off in the fridge, and creating leftovers.[129] Many studies show that meal planning and making lists are positive influences on food waste reduction with people who plan their weekly menus less likely to overbuy.[130,131] As well as relating to consumer behaviour, drivers such as overpurchasing are also influenced by retail or food service marketing strategies that encourage consumers to buy more than they need, such as 'buy one, get one free' deals.[131] Shopping at large supermarket chains is also correlated with larger amounts of food waste rather than growing one's own food, buying from small shops or local markets.[132]

…drivers such as overpurchasing are also influenced by retail or food service marketing strategies that encourage consumers to buy more than they need, for example 'buy one, get one free' deals.

Knowledge around food safety and cooking or preservation techniques can influence food waste generation during storage, preparation, and consumption. An estimated 8.2% of total household food waste is leftovers, making it the second highest category of avoidable household food waste, behind bread.[125] Proper storage, such as in the fridge or freezer, can prolong the shelf-life of foods while improper storage accelerates food spoilage. Inappropriate decision making around whether food is safe to eat is also indicated as a driver for avoidable food waste. Date labels can play role in informing (or confusing) consumers about food safety as well as quality and consumers should be encouraged to use this information along with their own judgement.[133] Studies have highlighted a lack of knowledge around proper storage, such as the right temperature for a fridge, and low confidence in food management skills like stock control.[131,134] Preparation waste includes discarding what is inedible or perceived as undesirable, such as broccoli stalks or potato skins.[131]

Date labels can play role in informing (or confusing) consumers about food safety as well as quality…

Socio-cultural drivers for household food waste underpin individual behavioural drivers. For example, the reality of consumers' lifestyles can be seen as a driver for food waste when a lack of time, energy, and money people have available to spend on food practices may contribute to a lack of capacity to minimise food waste.[135,136]

Behaviour change and system change

Preventing household food waste requires employing both interventions that aim to change the behaviour of individual consumers, as well as those that drive change at a system level.

Multi-pronged campaigns that use information, community engagement, and tools to remove barriers to prevention (e.g. timely prompts or food waste measurement tools) can be especially effective in changing behaviour to reduce household food waste.[67] The delivery of campaigns can vary from global campaigns such as 'Think. Eat. Save' spearheaded by the UN Environment Program (UNEP) and the Food and Agriculture Organisation of the UN (FAO),[137] to more targeted campaigns in local areas or with specific demographics in mind. The most prominent multi-pronged campaign in Aotearoa is the 'Love Food Hate Waste' campaign, administered by WasteMINZ[61] and based on the model of the same

The multi-pronged element is crucial in information and communication campaigns…

name in the UK.[138] The multi-pronged element is crucial in information and communication campaigns to overcome an unsubstantiated assumption that awareness leads to behaviour change, when in reality, there are likely to be other barriers to behaviour change that need to be simultaneously addressed. Interventions to help consumers reduce food waste are typically assessed through survey or bin data to understand the effects of the interventions on food waste prevention and preventative behaviours. However, consistent and reliable evaluation of effectiveness is a challenge[139] and is not always definitive.[32] This does not necessarily mean that these interventions don't work, rather that multiple interventions are often combined and may act interdependently with interaction effects making it challenging to assess the effectiveness of any single intervention.[140]

Policy levers to drive system level changes to prevent food waste include setting strategic direction, as well as enacting legislation and regulation, and facilitating infrastructure and services that reduce food waste. An integrated approach to high level FLW policy and local or regional food waste reduction action plans, such as MfE's waste strategy,[44] can benefit and influence community level engagement,[139] increase consumer awareness, and facilitate support to make changes through community led-initiatives. Mandatory reporting for food waste, such as from kerbside collections, could make food waste more visible to the public and promote prevention within households through the act of separating food waste from general waste.[129]

Table 2 shows a list of key opportunities for preventing FLW. These and the information summarised in this section are expanded upon in our report *Preventing food loss and waste in Aotearoa New Zealand: Evidence from across the supply chain*.

Table 2: Key opportunities for FLW prevention. Abbreviations: the Code = the Grocery Supply Code, FLW = food loss and waste, GDSN= Global Data Synchronisation Network, MPI = Ministry of Primary Industries, SAPs = sector action plans, MOU = Memorandum of understanding.

Opportunity	Readiness	Potential outcomes
Improve data and monitoring of FLW across the supply chain.	The forthcoming national baseline measurement will both provide data and highlight data gaps. Organisations like Kai Commitment actors in the food rescue sector continue to collect data. National food waste reduction programmes[141] funded by MfE have monitoring components by design.	FLW 'hotspots' are more transparent, enabling effective intervention opportunities (e.g. data-informed SAPs). A reliable evidence base strengthens and further enables effective policy and strategy.
Develop SAPs that prioritise prevention.	SAPs exist in Australia[142,143] and the UK[144] and could be adapted for NZ, with local sector input and appropriate resourcing.[e]	Prevention strategies and initiatives are better developed, well coordinated, and consider upstream and downstream impacts on FLW.
Explore secondary market opportunities for suboptimal food.	Data and research are needed to identify the scale and feasibility of opportunities for secondary markets. Developing SAPs for primary industries (e.g. horticulture, meat, dairy) could provide an avenue for this research.	The loss or waste of suboptimal food is prevented, meaning this food is accessible to and purchased by consumers. Improved secondary market options reduces the risks of food loss for growers.

[e] Note international best practice is for these to be administered by an independent body. In the UK, this body is Waste and Resources Action Programme (WRAP), in Australia it is End Food Waste Australia (EFWA). This is further discussed in section 4.1.

Opportunity	Readiness	Potential outcomes
Explore how collaborative business structures (like cooperatives) and knowledge sharing agreements (such as MOUs) could facilitate sharing FLW prevention practices and improve their effectiveness.	Primary industries like dairy and kiwifruit have cooperative business structures and MOUs in place. Further research is needed to understand the impact of these approaches on FLW and whether they could be extended to other industries. Solutions exist within individual businesses, but mechanisms to share best practice with other sectors are often lacking.	FLW is prevented rather than shifted to other parts of the supply chain. Risk is distributed fairly among supply chain actors, with reduced overproduction and FLW given altered supply and demand dynamics and collaborative relationships.
Explore integrated logistics and forecasting technology.	Mechanisms are still needed to share data that already exists within and between businesses. One such mechanism is GDSN technology,[145] designed to improve data sharing and interoperability.	Logistical and operational inefficiencies and issues within supply chains are significantly reduced, better aligning supply and demand and reducing FLW.
Explore crop management technology to reduce food loss from weather, pests, and disease.	As explored in *Preventing food loss and waste In Aotearoa New Zealand: Evidence for action across the supply chain*, this is already happening within industries and businesses. Further research with a strategic FLW lens, as well as dissemination of findings, could enhance gains.	New and improved crop management technologies reduces the amount of food loss from weather, pests and disease, particularly in the context of increasing extreme weather events due to climate change. As a result, farmers are far less reliant on overproduction as a risk mitigation strategy.
Investigate the role of quality control, cosmetic specifications, and supply agreements.	The new Grocery Supply Code[36] may help to create more equity and transparency in supply agreements, and in turn provide suppliers with more certainty around required production volumes. However, the Code's remit does not currently extend to FLW specifically.	FLW is prevented from being pushed up or downstream along the supply chain, as equitable trading practices provide fair market power among supply chain actors. Additionally, mechanisms for regular evaluation and review are in place.

2.3 Rescue for people

Food rescue is the process by which surplus food at risk of going to waste is captured for human consumption. It offers an important immediate solution to surplus food and contributes to the alleviation of hunger. Food rescue doesn't combat the root causes of surplus food or food insecurity, serving as an 'in the meantime' solution while efforts to prevent surplus food at source and alleviate poverty are pursued. Food rescue will continue to play an important role, especially during and directly following disasters and disruptions, when there is both unexpected food surplus and a potential increase in food insecurity. Work is currently underway by Manaaki Whenua | Landcare Research to understand the role of food rescues during disaster relief and other disruptions.[146]

Food rescue contributes to social good by nourishing people, in particular, those experiencing food insecurity (21.3% of children live in households reporting that food runs out sometimes or often, with Māori and Pacific peoples disproportionately affected).[31] Nourishing food insecure people can provide broader social benefits as well, including: contributing to community building and a sense of whanaungatanga (relationship, kinship, and a sense of family connection); linking people experiencing food insecurity to wraparound services; and providing an opportunity for volunteerism and the associated benefits. A recent New Zealand-based study estimated that every dollar invested in food rescue provides a social return of $4.50.[147] Food rescue stops surplus food from being landfilled, composted, or otherwise managed at a lower tier in the food recovery hierarchy and has potential to grow; it has been estimated to capture less than 1% of total FLW in Aotearoa.[f]

A recent New Zealand-based study estimated that every dollar invested in food rescue provides a social return of $4.50.

A diverse range of approximately 300 organisations[148] engage in food rescue in Aotearoa, employing different operating models and working on different scales:

- The New Zealand Food Network (NZFN) rescues bulk food at risk of going to waste, primarily from producers, processors, and manufacturers. That food, along with purchased food, is distributed to 61 community food hubs, which pass the food along to food insecure communities.
- The Aotearoa Food Rescue Alliance (AFRA) represents most food rescue organisations in Aotearoa and is a collaborative capacity-building organisation.
- Community food hubs, mixed-model food rescue organisations, and freestore organisations primarily rescue surplus food from the retail and food service sectors. Food rescue organisations often use food to facilitate access to wrap around services and practices. In most cases, food rescue organisations pass food on to a third-party community support organisation who are best placed to provide these wrap around services.
- Informal sharing: Community food pantries are distributed throughout the country, and informal community or app-based sharing economies contribute to surplus management.

The COVID-19 pandemic, and the associated pandemic control measures, catalysed significant growth in the food rescue sector, triggering significant increases in government funding as well as highlighting our vulnerability to both food insecurity and disruptions in the supply chain. Approximately 11,500 tonnes of food were rescued in 2021 and distributed to food insecure New Zealanders.[149,150] COVID-19 related funding has subsequently ceased; however, MSD's Food Secure Communities programme currently funds many food rescue organisations (at a reduced rate compared to during the pandemic). This funding is to support the distribution of food relief rather than food rescue specifically.[59] During the pandemic, temporary legislation provided tax relief to businesses donating food. In 2024, this was legislated permanently,[151] a recommendation from our previous report *Food rescue in 2022: Where to from here?* This recent change will help to incentivise businesses to keep good food for people.

There are some key challenges facing the food rescue sector in Aotearoa that could be addressed in various ways to help strengthen their role in combatting FLW in New Zealand, without locking in systems of surplus by design or systemic food insecurity. These opportunities are broadly outlined in

[f] Section 3.1 of our second report *Food Rescue in 2022: Where to from here*? explains how this figure was calculated. We acknowledge that this is a contested figure but discern that it is evidence-based.

table 3. These opportunities as well as a more in-depth dive into the food rescue sector are expanded upon in our previous report, *Food rescue in 2022: Where to from here?*

Table 3: Key opportunities to rescue food for people in Aotearoa. Abbreviations: AFRA = Aotearoa Food Rescue Alliance, FLW = food loss and waste, SAP = Sector Action Plan, SROI = social return on investment.

Opportunity	**Readiness**	**Potential outcomes**
Undertake further research into food safety practices.	Existing food safety guidelines by AFRA provide a helpful starting point, but additional resourcing is needed to build on this work.	By ensuring food safety protocols work, there is reduced donor anxiety, and more empowered end users. Subsequently, more food is safely available for rescue.
Explore sustainable funding models.	Further work is required to understand how future government support and exploration into the effect of waste levy and tax incentives would support food donors.	Implementing sustainable funding models has set a foundation for long term strategic planning for the sector.
Develop robust, NZ specific data collection to understand the impacts of food rescue for people.	Utilising a recent SROI study[147] would provide a base to begin data collection work.	NZ specific data enables the assessment of different models and communication of the impacts of food rescue initiatives.
Explore technology aids for food rescue operations.	As explored in *Food rescue in 2022: Where to from here?*, options are already being rolled out locally and abroad, including digital platforms linking donors and recipient organisations, as well as inventory management tools.	Using technology to aid operations achieves greater efficiency and better connects stakeholders to donors, rescue organisations, and end users, as well as increasing food available for rescue.
Develop consistent upskilling in the rescue sector.	AFRA provides centralised resources for upskilling staff and volunteers. However, this requires ongoing long term resourcing.	Incrementally upskilling personnel ensures the quality and safety of food rescued. The volunteer workforce is better equipped for their roles.
Facilitate cooking and/or processing of rescued food for food that is unable to be directly consumed.	Further work to connect or enable access for food rescue organisations with processors and commercial kitchens is needed.	Being able to cook and process donated food has the dual benefits of reducing waste of rescued food and providing end users with food fit for purpose.
Prioritise nutrition.	While some nutrition focused policies are already in place within rescue organisations, further research is needed into the nutritional impacts of food rescue.	Improved nutrition in overall diets for end users as more nutritious food is prioritised.
Support long term shifts towards food sovereignty rather than food welfare.	Organisations such as Para Kore[152] are already working to strengthen food sovereignty through their programmes. A food rescue SAP could support a transitional framework nationwide.	Achieving food sovereignty provides end users with resilience against food insecurity and reduces factors that lead to overproduction, in turn reducing FLW.

2.4 Upcycle to new food products

Upcycling is the process of turning FLW into new products.[77] While recognising that this practice has been used in domestic kitchens for centuries, and should be encouraged in modern households, we take the lead of US-based Upcycled Food Association and limit our discussion to upcycling undertaken by businesses, meaning that the end product must be commercially viable.[153]

The upcycled food industry had an estimated market value of US$55.1 billion globally in 2023,[154] up from US$46.7 billion globally in 2019.[155] In Aotearoa, an increasing number of companies are bringing upcycled products to market and there is reason to believe that New Zealand consumers are open to upcycled products, but appropriate research both in product development and in marketing will be necessary to identify niches for new commercially successful upcycled foods.

The upcycled food industry had an estimated market value of US$55.1 billion globally in 2023…

2.4.1 Upcycled food in context

Upcycled food represents a commercial opportunity that could deliver economic and environmental benefits, as well as increase consumer awareness and engagement with the FLW issue. However, there is a risk that it could incentivise food to be upcycled that could have been prevented. One study[156] highlights this challenge and suggest that there are two broad types of upcycling:

- Alternative use upcycling prevents the waste of food that is theoretically good to eat but is currently wasted (e.g. surplus bread, imperfect produce).
- Novel use upcycling prevents the waste of food parts or ingredients that are commonly regarded as inedible or not widely eaten.

Our recommendations are designed to ensure we enable but do not lock in less preferred approaches to our FLW challenge for the long term. Encouraging the sector in the direction of 'novel use' upcycling through the allocation of research and development funding as well as a meaningful upcycled food certification (such as the one developed by the Upcycled Food Association and used throughout North America)[157] could help to guard against greenwashing. This approach is taken by End Food Waste Australia (EFWA), which focuses its upcycling efforts on genuinely unavoidable FLW that doesn't increase emissions compared to wasting it.[158] Another concurrent strategy could be to reduce the need for alternative use upcycling through initiatives such as relaxing product specifications and finding secondary markets for this type of food.

Nutrition and food safety should be factored into upcycling efforts. Upcycled foods are often highly processed, discretionary foods, but measures can be taken to drive the development of the upcycled food sector towards more nutritious products.[77,159] Potential measures include: prioritising nutritious source materials like whole grains; producing staple rather than discretionary foods; and prioritising nutritional profile in processing. Aligned with certification efforts, including a verifiable and auditable supply chain as part of the upcycling approach can contribute to food safety efforts and help with consumer acceptance of upcycled products.[77] Key opportunities for the upcycled food sector are summarised in table 4. All of the information presented in this section is expanded upon in section 3.1 of our previous report, *Beyond the bin: Capturing value from food loss and waste*.

Table 4: Key opportunities to upcycle surplus food that can't be prevented to new food products. Abbreviations: BPA = Bioresource Processing Alliance, CODC = Central Otago District Council, EFWA = End Food Waste Australia, FLW = food loss and waste, MBIE = Ministry for Business, Innovation and Employment, SFF = Sustainable Food and Fibre.

Opportunity	**Readiness**	**Potential outcomes**
Connect surplus food with processors and manufacturers.	Work by CODC, funded by the BPA and SFF Futures, to upcycle underutilised fruit provides an indication of the scale of the problem and the opportunity[g,66] Identifying further opportunities requires 'mapping' of local food systems, in particular to establish partnerships between stakeholders with complementary capabilities.[160]	Surplus food is efficiently utilised because it's accessible to, and used by, processors and manufacturers to create new products. This keeps surplus food in the food supply chain (when environmentally and economically viable) that would otherwise go to less preferred destinations in the food recovery hierarchy.
Support innovation for upcycled food in New Zealand.	MBIE currently funds the BPA to develop innovations for material recovery from organic waste streams.[161] Some upcycled food businesses already exist in NZ, but they would benefit from facilitated connections as a network (as has been recommended in Australia).[160]	Upcycling increases the utilisation of foods that would have otherwise been wasted or not used by people. Novel upcycled food products provide valuable opportunities for entrepreneurs and businesses to address FLW issues and provide consumers with more ethical food choices.
Adopt an upcycled food certification.	Certification of upcycled food products is already being adopted in North America.[157] There is scope for this to be extended to NZ and Australia.[160] NZ could work with EFWA to enact trans-Tasman certification for food industries.	Upcycled food certification ensures integrity of the term 'upcycled food' on product labels. Consumers can be confident these foods are sustainable, reduce overall emissions, and are not removing food from the supply chain that could have been prevented or rescued.
Educate consumers about upcycling and its benefits.	Research suggests NZ consumers have an appetite for more upcycled products.[162] Raising awareness and subsequently driving demand is essential to the success of the upcycled food sector.[160] Currently there is no coordinated approach in NZ, but there is some messaging by upcycled brands. Utilising resources available for members from the Upcycled Food Association in the US could provide valuable lessons in this space.[163]	Consumers, who are motivated to make ethical food purchases, choose to purchase upcycled foods because they know these foods are sustainable, reduce overall emissions, and are utilising food that would have otherwise gone to waste. This in turn drives consumer oriented businesses to increase upcycled product offerings as a profitable revenue stream, further utilising (and reducing) FLW.

[g] Case study 3 in our previous report *Beyond the bin: Capturing value from food loss and waste* provides an overview of this project.

2.5 Animal feed

Globally, significant land use and emissions are associated with the production of crops for animal feed,[1,5,164,165] and so replacing some of these with products derived from FLW, such as grape marc, would have positive environmental impacts.[166] In New Zealand, up to a quarter of agricultural animal feed already derives from FLW (including grain, vegetable, and animal by-products).[h,167] However, we still grow and import products for feeding animals (including pets and livestock). Palm kernel expeller from Indonesia and Malaysia accounts for over half of imported animal feeds,[168] and soybean meal is also imported from Argentina[167] – both of which are linked to deforestation. In addition, about 15% of animal feed ingredients could be directly eaten by people so are considered 'food-competing feedstuffs'.[1,5,164,165,169]

In New Zealand, up to a quarter of agricultural animal feed already derives from FLW [but] we still grow and import products for feeding animals (including pets and livestock).

The value of feeding FLW to livestock should be kept in context. Feeding FLW to animals would provide only a minor offset to the wider environmental challenges of methane emissions from ruminant agriculture.[170,171] It is not always desirable for all by-products to be removed from the food supply chain and diverted to animal feed. For example, some food system by-products form part of sustainable nutrient cycling systems when left in the field.[169] However, using FLW as animal feed, and taking care not to substitute FLW streams into animal diets where they reduce productivity or increase enteric emissions, is one way to make incremental improvements to the emissions profile and wider environmental footprint of animal-based agricultural systems.

The barriers to incorporating more FLW into animal feeds are largely technical. Agricultural animal feed must support both the productivity and the welfare of the animal, and there is variation in how different sorts of FLW perform in these domains. For example, fruit and other high energy foods can result in acidosis[i] in livestock. Care must be taken to avoid mineral and nutritional imbalances when introducing such feeds.[172] There are additional biosecurity considerations – and regulations – that limit when meat can be used in animal feed, to avoid inadvertent transmission of disease.[j]

Agricultural animal feed must support both the productivity and the welfare of the animal, and there is variation in how different sorts of FLW perform in these domains.

As well as technical barriers, there are also logistical challenges. Waste needs to be transported for processing and distribution to where it is needed. Exacerbating this, FLW generally has a short shelf-life with potential for mould or pathogens if not consumed promptly.[172] FLW is also more variable

[h] Figure 20 in our previous report *Beyond the bin: Capturing value from food loss and waste* provides a breakdown of the FLW used as animal feed.

[i] Acidosis in livestock is a disease that occurs when an animal's pH levels fall below normal.

[j] These barriers are expanded on in section 3.2 of our report *Beyond the bin: Capturing value from food loss and waste*. Mechanisms for mitigating the risks are detailed in annexes 6 and 7 of that report. At the time of writing, we are aware that an MPI-led review of Biosecurity (Meat and Food Waste for Pigs) Regulations 2005 is ongoing, which may have some relevance for food waste.

than purpose-grown crops, in terms of availability, volume, and composition, which makes planning more difficult. Key opportunities for this sector are summarised in table 5.

Table 5: Key opportunities to recycle food for animal feed. Abbreviations: FLW = food loss and waste.

Opportunities	Readiness	Potential outcomes
Connect people with suitable FLW to livestock farmers.	As discussed in *Beyond the bin: Capturing value from food loss and waste*, there is early pilot work in this space, but greater utilisation of FLW in feed could be realised through 'mapping' local food supply chains to identify more opportunities.	More growers and businesses are aware of local animal feed options and divert FLW that is no longer edible for people to livestock farmers. This helps optimise FLW diversion strategies, when environmentally and economically sensible.
Develop safe and effective pathways for FLW to be used as animal feed.	Further research is needed to develop protocols and best practice guidelines to ensure safe and effective storage, transport, and use of FLW for animal feed.	Pragmatic protocols and guidelines that are research based inform the use of FLW as animal feed, in turn reducing biosecurity risks and improving animal welfare and animal product quality. By improving farmer confidence and the price-point of feedstocks, this helps achieve the overall goal of increasing the proportion of FLW-derived matter in animal feeds.

2.6 Material, nutrient, and energy recovery

According to the definition for FLW developed by MfE in 2023, activities lower on the food recovery hierarchy than animal feed are officially considered food loss or waste,[12] including material, nutrient, and energy recovery, as well as disposal. These types of recovery are defined as;

- Material recovery refers to by-products or inedible components from food production or processing used to make non-food products (such as wool, leather, and collagen in beauty products).
- Nutrient recovery, a sector largely dominated by composting, refers to the process of extracting valuable nutrients from FLW so that they can be used in agricultural systems, gardens, and to regenerate natural environments.[6]
- Energy recovery refers to the range of processes for capturing energy from calories in FLW.

A recent infrastructure stocktake[173] estimates that New Zealand produced approximately 4 million tonnes of organic waste in 2021, the percentage of which is FLW is unknown.[k] Of this waste, 2.2 million tonnes were recovered, either via composting or rendering, while 1.8

A recent infrastructure stocktake estimates that New Zealand produced approximately 4 million tonnes of organic waste in 2021, the percentage of which is FLW is unknown.

[k] The percentage of food waste may be known in some cases but cannot be shared due to commercial in confidence data sharing practices.

million tonnes were disposed of to landfills or on farms. Importantly, this estimate does not include food lost and/or recovered on farms.

Material and nutrient recovery is a challenge big enough for multiple solutions at different scales. There are many instances where different processes can work in a complementary fashion to maximise the value extracted from wasted food. In addition to inter-linking technological processes, we can combine their products, playing to their relative strengths. Importantly, one size does not fit all, and any interventions need to allow for the specific constraints and opportunities of local solutions to FLW.

Material and nutrient recovery is a challenge big enough for multiple solutions at different scales.

2.6.1 Material recovery

By-products from food production can also be used to make non-food products. These products are often described as 'biobased materials' [174] but for simplicity we refer to this tier of the food recovery hierarchy as ‘material recovery’. Efforts to fully utilise plants and animals grown for food have increased globally, both to boost financial returns from food production, and to reduce waste and the impacts of climate change.[175]

New Zealand has developing expertise in this field and the potential to grow further, using by-products from animals grown for food, fish products, and horticultural crops. New Zealand’s bioeconomy has traditional by-products, such as wool from sheep, leather from farmed animals, and velvet from deer antlers, all of which are widely produced and contribute to export earnings.[176] The Ministry for Business, Innovation and Employment (MBIE) funded Bioresource Processing Alliance (BPA), involving three Crown Research Institutes (CRI) and Callaghan Innovation, has been set up to work with the primary industries to get better value out of biological by-products.[37] For many companies, going from lab trials to market is a challenging step. There is scope for more work in this space, and MBIE has recently published a relevant report series.[166] Section 3.3. of our previous report, *Beyond the bin: Capturing value from food loss and food waste* expands on material recovery, including case studies of existing products.

New Zealand has developing expertise in this field and the potential to grow further, using by-products from animals grown for food, fish products, and horticultural crops.

2.6.2 Nutrient recovery

FLW holds valuable nutrients, which can be extracted to improve soil health and condition and regenerate the environment. Capturing the nutrients in FLW provides the opportunity to ‘close the loop’ in nutrient cycles.[42,177,178] The nutrients found in FLW can be used as feedstock for another cycle of food growth[179] and to restore soil structure, microbial functioning, and nutrient composition.[42,177,178] Various processes enable nutrient recovery from FLW, with commonly practiced methods including composting, vermicomposting, ploughing back into soils, and anaerobic digestion (AD).

While the food recovery hierarchy places nutrient recovery near the bottom of the priority list, te ao Māori and kaupapa Māori perspectives often prioritise soil sovereignty and place importance on

returning nutrients to the soil in order to enhance the mauri and mana of the whenua.[l,79,180] Context specific perspectives such as this need to be considered to give necessary nuance to solutions that are not provided by the food recovery hierarchy.

Nutrient recovery has the potential to reduce our reliance on imported fertilisers that disrupt soil processes and may contribute to the deterioration of soil health, microorganisms, and biodiversity.[181] Per hectare of land, Aotearoa is third in the world for fertiliser consumption[182] and our use of nitrogen has been steadily increasing since the early 1990s.[183]

Composting and vermicomposting dominate the nutrient recovery sector. As well as industrial scale facilities, both composting and vermicomposting can operate at local scale, which provides additional social benefits. In New Zealand, there is a well-established commercial composting sector with 62 active large-scale facilities that process organic waste (although not all of these facilities process FLW)[173] and a wide network of compost clubs and social enterprises operate across the country to compost food waste within communities (see box 5, *Beyond the bin: Capturing value from food loss and waste*). Another way to recover nutrients for soils is to apply digestate from AD processes, which is discussed in the context of energy recovery (see section 2.6.3 below). This is not yet widespread in Aotearoa but is likely to grow.

To carry out nutrient recovery in a commercially viable way requires consistency in supply and specifications for the waste-derived product to at least match those of synthetic fertiliser. Work is required to understand how this substitution can be made while maintaining product yields and quality. Section 3.4 of our previous report, *Beyond the bin: Capturing value from food loss and food waste* expands on nutrient recovery as an avenue for FLW management.

2.6.3 Energy recovery

A range of processes exist for capturing energy from waste, but most are poorly suited to FLW feedstocks. AD is an exception. In AD facilities, microbes break down waste to produce a gas that can provide heat, used to generate electricity, or replace virgin natural gas.[184] Specific to FLW, New Zealand's AD market is in its infancy. Currently, we have one AD facility dedicated to FLW (see case study 15 in previous report *Beyond the bin: Capturing value from food loss and waste*) and two facilities that process industrial effluents from dairy manufacturing into biogas.

…biogas could replace 7% of current natural gas consumption in Aotearoa by 2050 and FLW is one of the most important feedstocks for biogas production.

Despite already generating a high proportion of our electricity from renewable sources, New Zealand faces challenges in dry years when hydro lake levels are low, and we will need to increase our supply of electricity as we transition transport and other key sectors to electricity from other energy sources. Using FLW to generate energy has some potential in this arena. A report jointly funded by industry and the Energy Efficiency & Conservation Authority suggests that biogas could replace 7% of current natural gas consumption in Aotearoa by 2050 and that FLW is one of the most important feedstocks for biogas production.[185] AD has the potential to displace some fossil derived fuel sources and the process can double as a nutrient recovery option. If used to its full potential, AD has the potential to be carbon negative [186,187] and, unlike landfills with gas capture, is fully contained.[188,189]

[l] Section 1.7 of our previous report, *Beyond the bin: Capturing value from food loss and waste* provides further detail about how te ao Māori perspectives can work alongside the food recovery hierarchy and circular economy thinking to reduce food waste in meaningful ways.

Expanding this sector would require significant investment in infrastructure and more work is needed in order to mitigate potential issues such as feedstock contamination and appropriate application of digestate. While biogas has potential as an energy source, particularly when upgraded to higher value products (e.g. biomethane), MBIE's most recent report on energy in New Zealand notes that biogas is only about 30% efficient[190] at conversion to electricity. Investment into the AD industry should be considered in the context of prioritising New Zealand's wider energy transition away from fossil derived fuels. Key opportunities for material, nutrient, and energy recovery of FLW are summarised in table 6.

Table 6: Key opportunities for material, nutrient, and energy recovery. Abbreviations: AD = anaerobic digestion BPA = Bioresource Processing Alliance, EPA = Environmental Protection Agency, ERP = Emissions Reduction Plan, FLW = food loss and waste, LCA = life cycle assessment, MfE = Ministry for the Environment.

Opportunities	**Readiness**	**Potential outcomes**
Develop a nationally consistent approach to FLW valorisation.	Frameworks like the food recovery hierarchy (see section 2.1), MfE's FLW definition,[12] and the US EPA's 'wasted food scale'[184] provide good starting points. Identifying the mutual benefits with the national waste strategy[191] is also valuable.	FLW that is ill-suited to destinations higher up the food recovery hierarchy is not landfilled, but rather utilised in more sustainable ways, consistent with international best practice and tailored to local contexts.
Explore policy levers such as banning FLW to landfill.	There is international precedent to explore banning FLW from landfills, with many countries, states, and cities adopting a variety of approaches (e.g. Austria[192-194]). In NZ, infrastructure for viable diversion of FLW is needed first. Exploring bans on organic waste is also a recommendation in the ERP.[42]	Capturing material, nutrient, and/or energy value from FLW is incentivised over disposal.
Invest in valorisation infrastructure.	Some infrastructure already exists, such as commercial composting facilities and an AD plant. The need for investment in this type of infrastructure has also been highlighted previously by MfE.[40]	More FLW is diverted from landfill, with economic, social, and environmental benefit. Products of energy recovery displace some imports (fossil fuels, and synthetic fertilisers), while nutrient recovery strategies generate healthier and more productive soils.
Develop a better understanding of current FLW hotspots, valorisation destinations, and impacts.	The forthcoming baseline measurement of NZ's FLW will highlight existing data and data gaps, but waste destinations are not included, and neither is life cycle analysis of valorisation options. There is clear need for nuanced data collection and analysis of both waste streams and valorisation infrastructure.	An evidence based FLW valorisation strategy directs investment that maximises positive environmental impacts.
Investigate valorisation models and technologies.	The BPA is already investigating innovative valorisation technologies for material recovery.[37] More work in this space with a systems focus is needed.	A reduction in the use of non-renewable materials in the food supply chain. For example, fewer unsustainable materials are used for packaging food products.

3 System problems need system solutions

While the food recovery hierarchy is a helpful way to prioritise actions to prevent FLW, on its own, it will not solve the problem. FLW has been described as a wicked problem – a problem that is unstructured, cross-cutting, and relentless – requiring management that is a "multilevel, multi-actor effort to prevent and reduce food waste through various solutions."[9] With this in mind, "food waste management requires shared responsibility of all actors at multiple levels from everyday life to the policy level."[9]

It is clear there are no silver bullet solutions for FLW and that meaningful change will require a multitude of actions and a holistic approach to problem solving that allows for action within all the contexts where FLW can be addressed.

There is a tension, when designing initiatives to combat FLW, between narrowly targeted changes to the status quo, and more fundamental system change. There is also a tension between addressing immediate problems versus focusing on long term solutions. Conventionally, FLW actions have emphasised more narrowly targeted and immediate outcomes and overlooked more systemic drivers and potential solutions.[22,98,195] Our recommendations and reports aim to strike a balance. On one hand we promote long term idealistic changes that aspire to a system without waste (as described in our vision). However, we also promote practical, feasible changes to address immediate problems within the system, so long as these are designed with systemic change in mind so as not to not contribute to 'locking in' non-optimal solutions. It is clear there are no silver bullet solutions for FLW and that meaningful change will require a multitude of actions and a holistic approach to problem solving that allows for action within all the contexts where FLW can be addressed. As well as employing the food recovery hierarchy, solutions should maintain circular economy thinking[196] and consider indigenous approaches to sustainable food systems, respecting kaitiakitanga.[80,197]

We are cognisant that actions to prevent or reduce FLW may have broader impacts – positive or negative – in the wider food system. Of particular concern are impacts that effect people or places disproportionately.

We are cognisant that actions to prevent or reduce FLW may have broader impacts – positive or negative – in the wider food system. Of particular concern are impacts that effect people or places disproportionately. For example, we know that Māori and Pacific peoples are over represented as food insecure[31] and almost a third of Māori owned businesses are in the food and fibre sectors.[198] Although out of scope of our *Project Framework*, it is important that any interventions intended to prevent FLW adequately consider such effects. Additionally, in a submission to the Commerce Commission, the industry body Horticulture New Zealand noted that in recent years consumers have faced increasing prices at the same time as the amount growers earn for their produce has declined.[199] Again, it is important that any interventions intended to prevent FLW do not exacerbate these dynamics.

Successful and meaningful system change requires a strategically aligned plan of action shared by all stakeholders who impact FLW as well as visibility of FLW across the supply chain and the wider social, environmental, and economic impacts. Because FLW is an issue that touches a huge variety of environmental, social, and economic issues, from the smallest to the largest of scales, there is a great number of stakeholders who either directly or indirectly impact the FLW landscape.

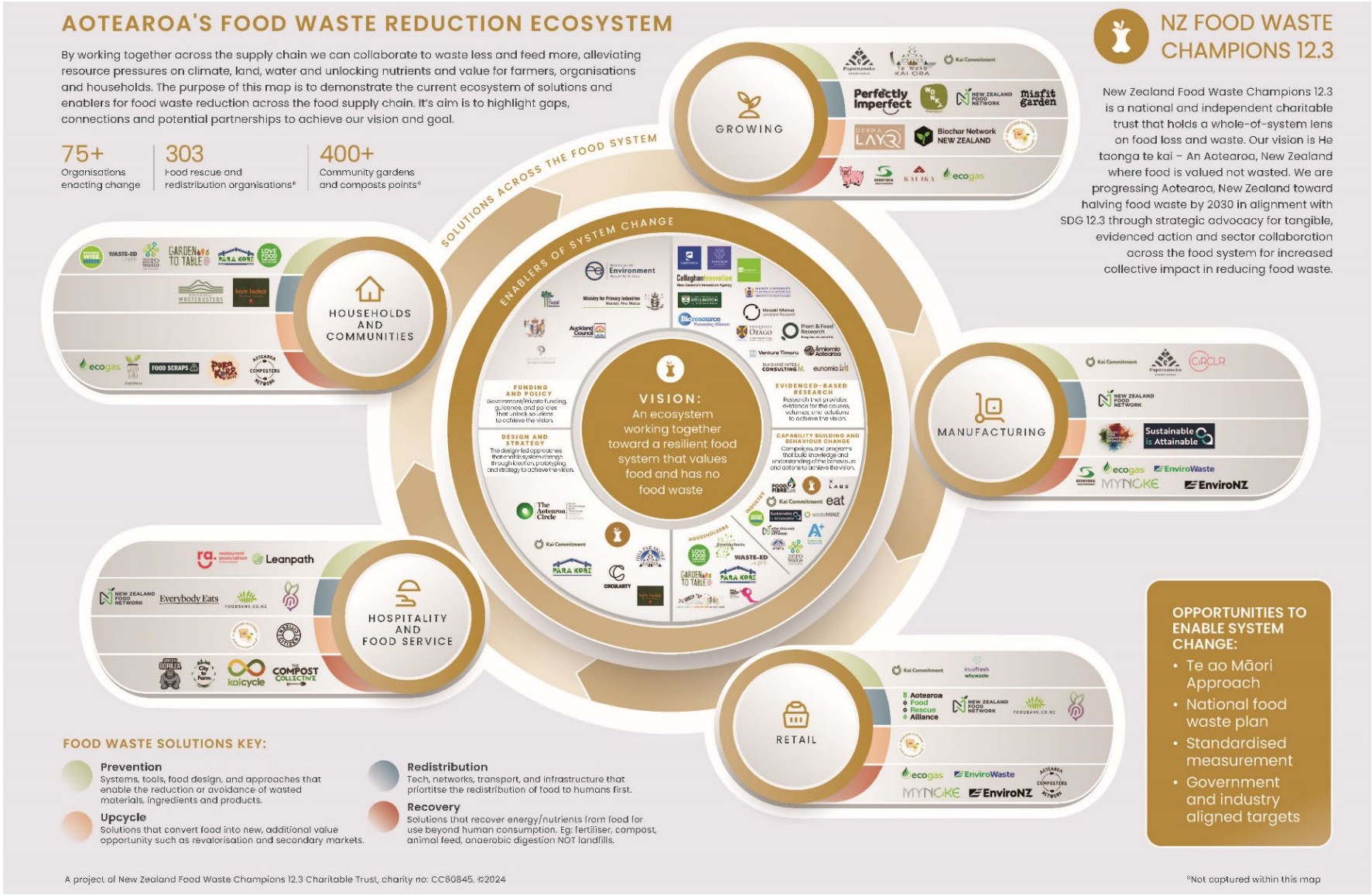

Figure 3: Aotearoa's Food Waste Reduction Ecosystem Map. Supplied by NZFWC.[148] See annex 1 for a map key.

3.1 New Zealand stakeholders working together

In Aotearoa, there are a wide range of experts and stakeholders with crucial knowledge and experience related to combatting FLW. This is illustrated by the 400+ strong reference group, listed in the acknowledgements, engaged in this project to understand the problem and potential solutions from all sides. NZFWC has recently conducted an exercise to map the FLW ecosystem in Aotearoa.[148] Figure 3 shows stakeholders from industry, government, research, and the not-for-profit sector and their roles in combatting FLW in Aotearoa. Annex 1 provides a written list of the stakeholders represented by their logos in the figure for easy reference. The map shows stakeholders by parts of the food supply chain, as well as by where along the food recovery hierarchy their work addresses FLW. In the centre of the map, actors in system change across the supply chain are identified by the type of work including policy and funding, evidence-based research, capability building and behaviour change, and design and strategy.

3.2 Stakeholders throughout the food supply chain

The pathway from where the raw ingredients that will become our food originate, to the places where we eat, form the food supply chain. Specific pathways differ for different kinds of food, but figure 4 shows a simple version that can be applied generally to most food products.

Figure 4: A simple schematic of the food supply chain.

It is well documented that each stage of the supply chain has unique FLW challenges and potential solutions. Grouping shared potential solutions by parts of the supply chain they apply to does not surface issues that need to be tackled across the whole supply chain.

Actions taken at any given stage, including actions that are not intended to impact FLW, can impact FLW in stages upstream and downstream (see section 1.2). The danger with targeted approaches to FLW reduction enacted without incentive to reduce FLW across the whole supply chain or without visibility of the whole supply chain, is that FLW may not ultimately be reduced, but simply pushed upstream or downstream to another part of the supply chain. For example, consumer preferences drive aesthetic and quality specifications that are set by retailers or marketers, which impact the product that producers can sell. Reducing food loss at production or primary processing by loosening cosmetic specifications without considering downstream effects, could result in this waste being pushed downstream to retail or to consumers when they are unhappy with the quality of the product and don't consume it.[14]

While up and downstream impacts can happen accidently and invisibly, this could also be used as a tool by food businesses to externalise their FLW and shift responsibility to other supply chain participants, society, or the environment. This is a particular risk where there is a concentration of market power.

While up and downstream impacts can happen accidently and invisibly, this could also be used as a tool by food businesses to externalise their FLW and shift responsibility to other supply chain participants, society, or the environment. This is a particular risk where there is a concentration of market power.[98] Strategic oversight of the whole supply chain – with systemic FLW and subsequent social, environmental, and economic impacts in focus – is required to effectively address FLW within the food supply chain.

3.3 Food loss and waste from local to global

FLW is a cross-cutting challenge not just because it is a multi-sector issue, but also because it is a multi-scale one. Aotearoa has a domestic food supply chain, but we also import food, and have a food-export based economy. FLW both occurs and is influenced by these different scales. Figure 5 illustrates some of these dimensions. For example, international stakeholders like the FAO can impact FLW in households, while individual consumer and advocate actions can also influence global trends and therefore FLW in global supply chains. It is important, therefore, to consider both potential influences of and impacts on FLW at different scales when making FLW related decisions.

FLW is a cross-cutting challenge not just because it is a multi-sector issue, but also because it is a multi-scale one.

As a food producing nation, New Zealand is well placed to prioritise FLW reduction nationally and regionally in food production-heavy regions and have great impact. Conversely, however, our food production sector is largely export based and so potentially more susceptible to international influences outside our control.

New Zealand also lacks competition in the marketplace in some sectors. In particular, in the grocery sector where two major players hold almost 75% of the revenue.[200] The opportunities this concentrated power presents for FLW reduction should not, however, overshadow smaller scale FLW reduction possibilities like grass roots community programmes as these will have different needs and goals.

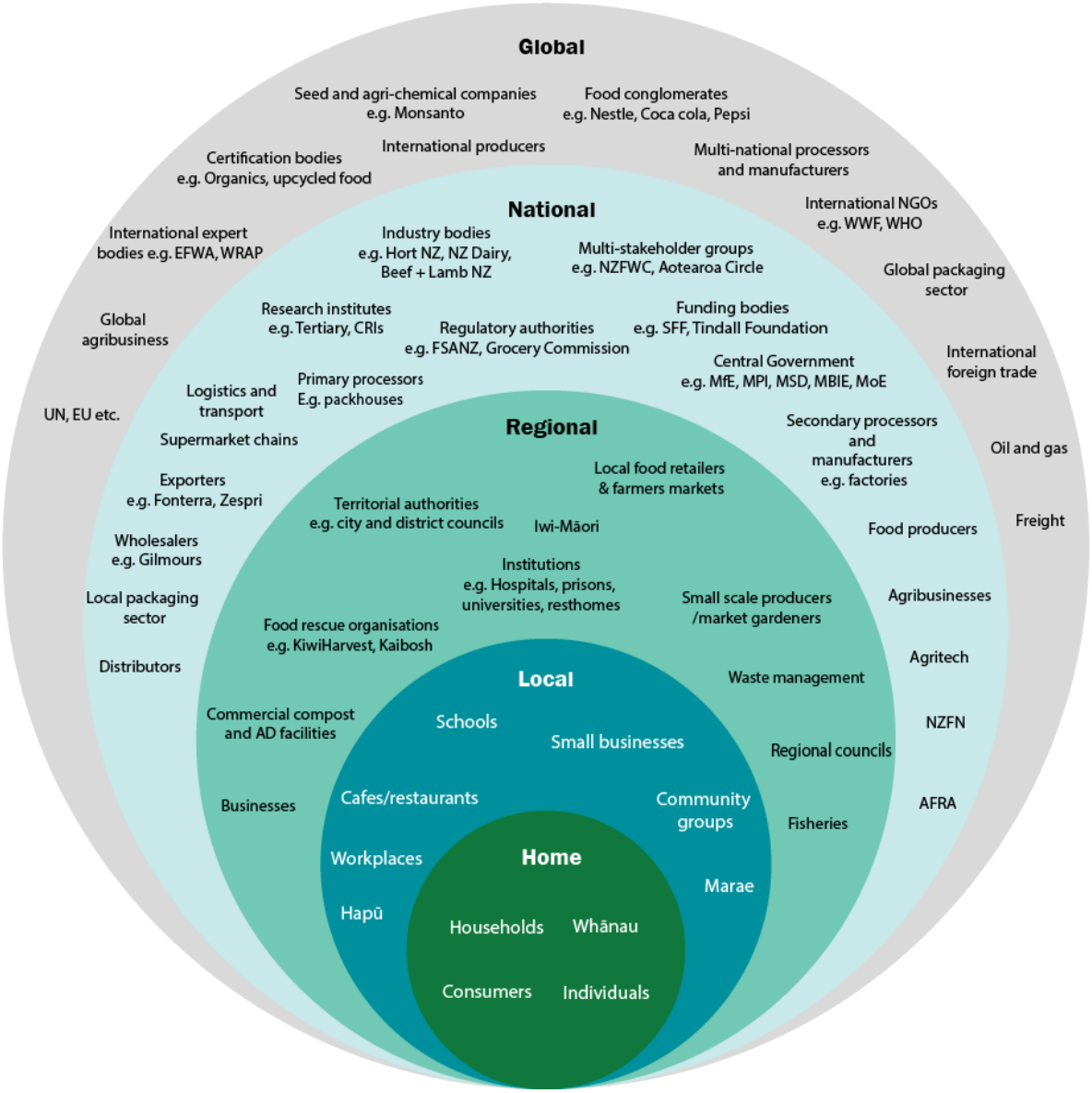

Figure 5: FLW stakeholders from local to global. Note that this is an illustrative not an exhaustive list of stakeholders. Abbreviations: AD = anaerobic digestion, AFRA = Aotearoa Food Rescue Alliance, CRIs= Crown Research Institutes, EFWA = End Food Waste Australia, EU = European Union, FSANZ = Food Standards Australia New Zealand, MBIE = Ministry for Business, Innovation and Employment, MoE = Ministry of Education, MfE = Ministry for the Environment, MoH = Ministry of Health, MPI = Ministry of Primary Industries, MSD = Ministry of Social Development, NGOs = non-government organisations, SFF = Sustainable Food and Fibre, WHO = World Health Organisation, WRAP = Waste and Resources Action Programme, WWF = World Wildlife Fund.

4 Key opportunities

We have a national definition for FLW[12] and the forthcoming national baseline measurement study will provide some information on volumes and hotspots. Conversations with the team at UoO, however, indicate some gaps in data have been identified. Data collection and evaluation should continue to be a priority to combat FLW in New Zealand. Opportunities around this are discussed in section 4.2. There are countless examples at all scales of stakeholders enacting FLW initiatives, many of which are detailed throughout this report series, but strategic support and a coordinated approach would make a real difference to system-wide reduction targets. For FLW reduction to be sustainable and effective, efforts need to keep the full range of societal, environmental, and economic factors in view as well as upstream and downstream effects of any FLW initiatives.

Data collection and evaluation should continue to be a priority to combat FLW in New Zealand.

…strategic support and a coordinated approach would make a real difference to system-wide reduction targets.

4.1 A coordinated strategic action plan for sustainable food loss and waste reduction

There is global recognition of a need for greater strategic food system governance in order to make national FLW reduction efforts more effective.[98,201] Our recommendations highlight some specific areas where strategic oversight would make a real difference. A coordinated national FLW strategic action plan[m] would align stakeholders and help to achieve more sustainable and effective FLW reduction. It should address and consider wider food systems, societal, environmental, and economic implications of FLW and FLW reduction. International examples of national FLW strategic action plans that could be drawn on include the UK's Food Waste Reduction Roadmap[144] and Australia's National Food Waste Strategy Feasibility Study.[202] Both of these examples provide oversight for the whole food system, but also include aligned specific- sector action plans (SAPs) developed in collaboration with stakeholders most influenced by or directly in control of the root causes of FLW, or play a major part in recovery (such as the food rescue sector).[98,201] Both examples also have an independent body to administer the strategic SAPs. In the UK, this body is the Waste and Resources Action Programme (WRAP) and in Australia it is EFWA. New Zealand could consider a similar approach and establish a strategic action plan with subsequent SAPs, administered by an independent body.

An coordinated national FLW strategic action plan would align stakeholders and help to achieve more sustainable and effective FLW reduction.

[m] Note that when referring to a 'strategic action plan', this is different from a 'sector action plan' (SAP). To avoid confusion, we have abbreviated 'sector action plans' to SAPs while 'strategic action plan remains written in full throughout this report.

4.1.1 Draw on existing collaboration

Some strategic oversight of FLW is already underway in parts of Government and there is an opportunity to build on this work. The Environment Committee's briefing to investigate food waste[33] recommended a 'target, measure, act' approach to FLW action. This approach was originally developed by WRAP in the UK,[144] and is also in line with other international approaches. MfE has adopted this approach by creating a national definition,[12] commissioning the national baseline measurement study, and funding a suite of food waste reduction projects.[39] MfE also has a national waste strategy[44] that includes FLW goals. There is an interagency food systems group and sustainable food systems project, but these have limited capacity.[67] There are examples of local governments coordinating and facilitating strategic action such as Central Otago District Council's workstreams for developing fruit loss potential.[66] As is detailed in table 1, there are also many other Government initiatives that have varying degrees of consideration of FLW goals that are much less coordinated and aligned, but have real impacts on FLW.

Outside of Government, there are efforts from industry, research providers, and communities to coordinate action on FLW both within and across sectors. Figure 3 illustrates this network and the various roles of stakeholders within the ecosystem. Most notably, NZFWC is a national multi-stakeholder charitable organisation whose kaupapa is a "whole-of-system lens on food waste".[203] They have detailed calls to action for Government, including a call to create a shared plan to reduce FLW that distributes responsibility for FLW appropriately.[204] NZFWC's key initiative is the Kai Commitment [205] (this project is receiving funding through MfE's national food waste reduction programmes[39]) a voluntary agreement for food businesses to reduce FLW and related emissions that is modelled on similar agreements abroad such as The Australian Food Pact.[206] UoO is leading the way for collaboration in the research space. UoO's Food Waste Innovation research group brings together investigators from around New Zealand and from a range of disciplines all working on combatting FLW in various ways.[207] Initiatives such as the Oranga Taiao programme run by Para Kore[152] and the Hua Parakore programme developed by Te Waka Kai Ora,[208] utilise mātauranga Māori to create a strategic approach to FLW in kaupapa Māori food systems and te ao Māori settings. Establishment and funding of AFRA and the New Zealand Food Network through MSD's Food Secure Communities programme[59] has greatly increased capacity, coordination and strategic oversight of the food rescue sector. There remain calls to align the multiple goals of food rescue to both reduce FLW and address food insecurity (see *Food Rescue in 2022: Where to from here?*).

…NZFWC is a national multi-stakeholder charitable organisation whose kaupapa is a "whole-of-system lens on food waste".

4.1.2 Checklist for an effective strategic action plan for food loss and waste

There are a number of elements a strategic action plan should incorporate in order to be effective in making meaningful changes that reduce FLW in Aoteaora. These elements are detailed and evidenced below.

An effective strategic action plan should…

…be evidence and outcome based

Drawing from what we have documented about FLW and successful initiatives and strategies in Aotearoa and overseas, an effective strategic action plan for FLW should have a clear vision of what reducing FLW looks like and work towards tangible and measurable outcomes with clear roles for all stakeholders. This also means that the ability for monitoring and evaluation will need to be built in to all interventions and initiatives. For a strategic action plan to be evidence-based, there needs to be robust evidence to draw from. As is discussed in section 4.2, improved data and monitoring is needed to be able to effectively address FLW. Interventions should always be designed in a way that their effectiveness can be evaluated so FLW action can continue to be effective in a changing landscape.[84] Although the academic and grey literatures are rich with suggested interventions to address the drivers of FLW across the supply chain, few of these have been formally evaluated. Robust quantitative data of the type necessary for evaluation is scarce so improving this should be a priority. It is also challenging to convincingly evaluate the impact of interventions that aim to contribute to system change, but qualitative analysis can be utilised alongside quantitative data to help mitigate this.[209] The lack of evidence should not delay action, rather ensure that a robust evaluation is built in to understand the effectiveness of the intervention.

…have accountability built in

To ensure intention is followed by action, a strategic action plan for FLW needs to build in mechanisms for holding parties accountable. For example, New Zealand could implement legally binding reduction targets, mandatory reporting of FLW, banning or sanctioning FLW to landfill, revising specifications and date labelling, and reviewing the scope of the Grocery Supply Code to include FLW reduction.[36] There are plenty of international examples of accountability mechanisms to draw from. The EU has recently implemented legally binding FLW targets,[210] and Norway are on a similar pathway.[107] There is legislation in France around mandatory donations of surplus food.[211]

…be guided by clear and evidence-based frameworks

The plan should consider the whole life cycle of food and not just the disposal destinations of food…

While each context is nuanced, there are some key principles that could be employed to guide the kaupapa of a strategic action plan for FLW. Firstly, New Zealand should follow international best practice by adopting the food recovery hierarchy, prioritising prevention of FLW and consider mechanisms to incentivise prevention of FLW, particularly where this is built in. Where FLW cannot be prevented, the plan should include creating incentives to keep it in the food supply chain where possible and appropriate and/or disincentivise options further down the food recovery hierarchy. This framework should be coupled with circular economy thinking and holistic systems thinking, keeping wider food system, societal, environmental, and economic considerations in view.[179,212] The plan should consider the whole life cycle of food and not just the disposal destinations of food when decision making to divert FLW. For example, undesired outcomes like the additional transport and processing emissions to create an upcycled product as well as the desired outcome of keeping it in the food supply chain should be considered. Considering the whole life cycle of food also includes accounting for the true costs of FLW and FLW interventions, even if these costs are hidden or transferred to society, the natural environment, or other parts of the food system.

…allow for local and New Zealand specific analysis and action, incorporating insights from te ao Māori

Although drawing from international examples will be crucial, a plan for reducing FLW in Aotearoa needs to be fit for purpose in New Zealand contexts. Cultural considerations including perspectives of Māori food systems and kaitiakitanga[197] will need to be incorporated, as well as other cultural, environmental, and economic characteristics of our food system such as our large export oriented food production sector and the ecological requirements of our landscapes. Solutions across the supply chain include changing behaviours of New Zealanders within all parts of the supply chain, in a way that generally means food is valued as a resource rather than as just a commodity. This includes consumers but also relates to those making decisions on the ground throughout the supply chain that ultimately create, prevent, or divert food being lost or wasted.

…a plan for reducing FLW in Aotearoa needs to be fit for purpose in New Zealand contexts.

…not overemphasise market-based solutions

FLW is often framed around resource efficiency and economic value recovery[98,195] but, as explained in section 1.2, overemphasising profit driven solutions can undermine efforts to tackle systemic drivers and root causes for FLW such as overproduction, and externalise true costs of FLW.[22,98] Continue to learn from successful interventions overseas. Overemphasising profit driven solutions can undermine efforts to tackle systemic drivers and root causes for FLW such as overproduction, and externalise true costs of FLW.[22,98]

…align policy, funding, and research and innovation

A key benefit of a national strategic action plan would be the ability to coordinate, prioritise, and appropriately sequence policy related to FLW across Government agencies as well as coordinate funding and investment in FLW initiatives and facilitate and prioritise research and innovation to reduce FLW and its related harms.

A recent FAO session on how to fight FLW in Asia and the Pacific region highlighted the need for policy-coherence by ensuring FLW is considered in all policies relating to agri-food systems.[201] Additionally, sequencing policy appropriately will ensure smoother adoption; for example, legislating mandatory reporting of FLW before establishing data collection methodologies infrastructure would inhibit compliance and effectiveness of the reporting. Aotearoa should look to international examples of different framings of FLW policy and learn from other countries to be strategic and purposeful in framing FLW policy in New Zealand.[98]

Funding and investment for FLW reduction comes from a variety of public and private sources with varying agendas. A plan facilitated by Government could support sustainable resourcing of key reduction initiatives and infrastructure that may not have incentives for individual stakeholders but will ensure appropriate prioritisation that benefits system-wide FLW reduction. Coordinated resourcing and coordinated public-private funding arrangements are key to long term success of FLW reduction efforts and avoiding solutions that may externalise true costs.[84,98] This particularly applies when there are more long term and systemic outcomes targeted.

Coordinated resourcing and coordinated public-private funding arrangements are key to long term success of FLW reduction efforts and avoiding solutions that may externalise true costs.

Businesses and communities around the country and internationally are busy creating their own FLW solutions. A strategic action plan for FLW should signal research and innovation priorities that work

towards reducing FLW across the supply chain, and minimises its related environmental, social, and economic harms. Where appropriate, the Government should also facilitate this research and innovation to happen in key gap areas, particularly in terms of research and development (R&D) and adoption of innovations for small and medium enterprises that work towards FLW reduction. Stats NZ data shows most R&D spending is by big businesses.[213] Research and innovation for FLW prevention is discussed in detail in section 7 of our report *Preventing food loss and waste in Aotearoa New Zealand: Evidence from across the supply chain*.

… include aligned sector action plans

SAPs account for the unique nature of different sectors and address specific factors that a system-wide strategic action plan is too broad to address. Both Australia[214] and the UK[144] has developed SAPs for specific industries to reduce FLW. These SAPs give context specific guidance that is aligned with overall FLW goals and plans. SAPs ensure buy in from a wide range of stakeholders, which will help to diversely inform the wider strategic action plan, so it is fit for purpose. SAPs also aim to empower all stakeholders to implement the challenges identified, recognising power imbalances between parties.[143,202] The Australian SAPs, published by EFWA, set out a framework (see figure 6) for supporting the delivery of SAPs. This framework demonstrates the collaboration and stakeholder buy in required to enact systemic FLW reduction initiatives.

SAPs ensure buy in from a wide range of stakeholders, which will help to diversely inform the wider strategic action plan, so it is fit for purpose.

Figure 6: The five pillars supporting the delivery of sector action plans in Australia. Image credit: End Food Waste Australia.[215] Abbreviations: KPI = key performance indicators, MERI = monitoring, evaluation, reporting and improvement.

4.2 Improve food loss and waste data and monitoring

The most recent estimate of global FLW indicates 40% of all food produced for human consumption is lost or wasted,[1] significantly more than a previous estimate in 2011 of 33%.[216] This increase is likely due to improved quantification methods.[1] The UN is now gathering more robust data since developing the FAO Food Loss Index [2] and the UNEP Food Waste Index.[76] Even so, global FLW figures are estimates and rely on extrapolation from a small number of data points with variable reliability. While targets such as SDG 12.3 are important envisioning tools, progress is difficult to assess without robust data as evidence of progress. See section 4.1 of our previous report *Food waste: A global and local problem* for further detail about global measurement of FLW.

…global FLW figures are estimates and rely on extrapolation from a small number of data points with variable reliability.

While understanding global FLW helps to inform the context for efforts to combat FLW in Aotearoa, our unique production and consumption patterns mean we need domestic data to truly understand the situation at home. We don't yet have an understanding of the extent of FLW in Aotearoa across the whole supply chain. We have some understanding of the extent of food waste at the consumer and retail levels, but less is publicly known about how much food is lost during production, processing, manufacturing, and distribution,[33] although this situation will start to improve with the forthcoming national baseline measurement study. There are also data collection efforts underway in the food rescue sector, driven by AFRA, and by signatories of the Kai Commitment administered by NZFWC. There is likely a lot more data on FLW within food businesses, but it is often collected for other purposes and is not easily translated as FLW data, is not standardised making it difficult to compare or extrapolate, and is often commercially sensitive.

…we need domestic data to truly understand the situation at home.

4.2.1 How does data help combat food loss and waste?

Improved data has been called for in various contexts across all the reports in this series, hence it is a key theme in our recommendations.

Not only is data important to facilitate more effective FLW reduction in specific sectors throughout the supply chain and food recovery hierarchy, but greater granularity around the overall volumes, nature, and location of food exiting the food chain and its destinations have implications more broadly as well. Robust data and monitoring can assist system change by:

Improved data has been called for in various contexts across all the reports in this series, hence it is a key theme of our recommendations.

- Making more effective modelling possible, which guides the design of initiatives and decision making around investment in FLW hotspots, and gives confidence to those investing in FLW reduction initiatives.
- Giving greater transparency of FLW in two ways:

- For FLW across the whole supply chain, to help make upstream and downstream impacts of actions more visible and effectively prevent or divert FLW, rather than push it to other parts of the supply chain. This will also help in designing initiatives that spread the risks of demand and supply more fairly. For example, while supermarkets may measure their own food waste, supply-chain-wide FLW data would help to show how actions made by supermarkets such as changes in orders based on demand impact food lost upstream.
- Understanding causes and destinations of FLW to ensure it is being utilised as best as possible and not pulled further down the food recovery and highlighting opportunities to divert FLW.
- Enabling forecasting to help prevent and divert unexpected FLW by improving dynamic problem solving capabilities.

Table 7 sets out a 'data wish list' for FLW, categorising the types of data and monitoring improvements that would enable FLW reduction. Data and monitoring opportunities specific to parts of the supply chain or parts of the hierarchy are explored throughout the report series and are included in our recommendations in each report, and are collated in this report but fit under these categories. The improvements to data and monitoring laid out in table 7 are very much aspirational, but achieving even some of them would make a meaningful difference to FLW reduction efforts in New Zealand.

Table 7: A wish list of the key types of data and monitoring improvements that would enable FLW reduction, including the outcomes if these were achieved. Abbreviations: AD = Anaerobic digestion, CODC = Central Otago District Council, EU = European Union, FLW = food loss and waste, LCA = life cycle assessment, MBIE = Ministry for Business, Innovation and Employment, PCE= Parliamentary Commission for the Environment, SROI = social return on investment, TA= Territorial Authority.

Category	**Data improvements needed**	**Readiness / Challenges**	**Outcomes**
Standardisation of data	Standard methods for measuring and categorising FLW.	• It is difficult to ensure data standardisation is fit for purpose across very different industries and parts of the supply chain. • International examples include ReFED's insights engine[217] and the EU's adopted common methodology.[218]	• Data sources are integrated and readily comparable.
	Accessible data for strategic system change decision making and design. E.g. a data platform that highlights FLW hotspots and trends.	• Commercial sensitivity means data would need to be anonymised and access to data or parts of data sets would need to be carefully considered and monitored. • Creating accessible data sets would require a large enough scale to achieve aggregation and anonymity.	• Reduction initiatives are informed by a holistic understanding of the flow of FLW throughout the supply chain.
Measuring and mapping FLW	An understanding of data that already exists within businesses and organisations and how it is captured.	• The national baseline measurement study will start to create this understanding. • This understanding will need to enable data captyre the enables both FLW and business data priorities. • Government could make more of its own data publicly available, e.g. household food scraps data (both where TAs collect and where private contractors collect on behalf of TAs).	• Data capture at a multiple levels (e.g. business, TAs, and nationally) is based on an informed strategy allows for standardisation and aggregation. • Gaps in data are identified and prioritised, with a reduced need for extrapolation.

Category	Data improvements needed	Readiness / Challenges	Outcomes
	Clear mapping of the food supply chain including the type, location, and destinations of food.	• 'Material flow accounts' were recommended in the resource use and waste generation review published by PCE in 2024.[219] MBIE are already doing work around digitalised 'material flow accounts'.[220] • Mapping can become a labour intensive process that creates a snapshot in time, rather than longitudinal information, unless effective reporting systems are put in place.	• The material flow of food through our supply chains is clear, including an overview of imports, excess, and waste.
	A comprehensive understanding of the types, volumes, and locations of FLW exiting the food system across the supply chain.	• Much of this data is not currently being recorded. • Data reporting could be unfeasible for many stakeholders without external support. • Data capture of this kind is labour intensive, and risks creating a snapshot in time rather than a longitudinal data set, unless reporting systems are put in place.	• FLW hotspots in the supply chain are clearly and quickly identified, as are the opportunities to address hotspots with appropriate prevention or diversion interventions and stakeholders. • Planning and evaluation of FLW reduction initiatives and interventions is evidence-based.
	A comprehensive understanding of the types of destinations FLW is diverted to (i.e. where along the food recovery hierarchy FLW ends up) the volumes and composition of ingoing feedstocks, and the volumes and destinations of outgoing products.	• Much of this data is not currently being recorded. • Data reporting could be unfeasible for many stakeholders without external support. • Data capture of this kind is labour intensive, and risks creating a snapshot in time rather than a longitudinal data set, unless reporting systems are put in place.	• The end destinations of FLW exiting the supply are clear, as is the use and value of FLW feedstocks. • Planning and evaluation of FLW diversion initiatives is evidence-based. • Hotspots are identified where FLW can be used further up the food recovery hierarchy.

Category	Data improvements needed	Readiness / Challenges	Outcomes
	A comprehensive understanding of causes and drivers for FLW across the food supply chain.	• An understanding of drivers is reliant on robust measurement of FLW, which is currently lacking. • Drivers are often complex and subjective, meaning it can be difficult to capture this data meaningfully. • There is an opportunity to draw on international best practice.[221]	• Substantive solutions address the root causes of FLW in different contexts.
Measuring impacts of FLW	Environmental, economic, and social impact data (e.g. LCA and SROI data) specific to NZ context for different food types lost or wasted through the supply chain as well as destinations throughout the hierarchy (e.g. food rescue, AD).	• This can be a labour intensive process, particularly as this type of data analysis is highly context specific and often unique for different products and/or destinations. In some cases, international examples can be used to guide NZ work, but there is a need to prioritise local context. • This type of work will need to include qualitative data and cultural considerations alongside quantitative analyses, which will have additional sensitivity and privacy considerations.	• Decision making to prioritise interventions is informed by a variety of factors, including environmental, social, and economic outcomes, with thought given to potential unintended effects.
Monitoring over time	Longitudinal FLW data to monitor effectiveness of reduction initiatives/interventions.	• Data already routinely collected in an ongoing way could contribute, e.g. food scraps data collected by TAs could be used to evaluate the effect of interventions on household food waste reduction in a city or district. • Because reduction initiatives will vary among stakeholders, monitoring and evaluation will need to be tailored to different initiatives.	• Evaluation of interventions is effective because longitudinal data collection allows for an assessments of change over time (e.g. before and after interventions). This also improves the ability to measure the impact of policy interventions.

Category	Data improvements needed	Readiness / Challenges	Outcomes
		• Data standardisation and accessibility are important foundations for effective monitoring.	
	Tools (e.g. software) to extract FLW data from more general reporting that food businesses already do, or a redesign of reporting platforms to accommodate multiple reporting requirements that includes FLW reporting.	• Deriving fit-for-purpose data (e.g. on FLW) from wider data set collected for different purposes poses a challenge and is a process that is not easily standardised. • We can capitalise on the data already being collected, and tailor its use for FLW research. For example, data gathered on household food scraps collections could be used to explore spatio-temporal patterns of FLW across cities.	• The use and availability of tools reduces the burden on stakeholders required to do reporting. • Resources are used efficiently to allow for multiple outcomes, e.g. emissions reporting and economic reporting as well as FLW reporting.
Forecasting and logistics	More accurate forecasting of consumer demand and preferences.	• The accuracy and complexity of demand forecasting models vary. • Retaining human oversight of forecasting models is a helpful safeguard against unforeseen inaccuracies in modelling.	• Improved predictability of consumer behaviours means that overproduction and spoilage is reduced, in turn reducing FLW along the supply chain.
	More accurate forecasting of supply chain disruptions.	• Many disruptions are unpredictable and therefore can't be forecast. However, forecasting systems that can react quickly to disruptions can still be helpful. • Human oversight in forecasting remains important as disruptions can require dynamic decisions about food redistribution and/or diversion.	• FLW is more easily prevented or diverted as forecasting systems enable better and faster problem solving when disruptions occur.

Category	Data improvements needed	Readiness / Challenges	Outcomes
	Improved connection and data sharing among local stakeholders (e.g. growers and processors) for redistributing or diverting food that is unable to stay in the regular supply chain.	• Existing connections vary by location. For example, the CODC project connecting fruit processors to surplus fruit is operational.[66] • Seasonal variability will present challenges even when information is shared. For example, processors may have limited capacity at certain times of the year. Similarly, gluts in the supply chain occur at certain times in the season.	• Local connections allow for improved FLW redistribution and diversion of surplus food, with notable environmental benefits (e.g. lower transport emissions).
	A more effective system to dynamically communicate logistics across the supply chain.	• Logistics communication strategies vary by sector. Expansion and/or improvement requires live data to be available across the supply chain. • Commercial sensitivity and practicality of dynamic logistics communications pose challenges.	• Effective and advanced logistics communications enable quicker decision, reducing the severity of supply chain disruptions of FLW.

4.2.2 Voluntary versus mandatory food loss and waste reporting

The most common approach to FLW reporting from food businesses is through enabling voluntary reporting to empower them to measure and commit to FLW reduction targets. The Kai Commitment in New Zealand mirrors similar voluntary agreements overseas; the Courtauld Commitment[222] and the Australian Food Pact[206] are two such examples. Currently, New Zealand does not have adequate FLW measurement and the monitoring infrastructure required to expect comprehensive reporting across the supply chain, but this should be a significant priority.

There is an increasing appetite internationally for employing mandatory reporting of FLW to enable fairer, more consistent, and robust reporting. Most recently, a coalition of over 30 major food businesses, including most major UK supermarkets, published an open letter to the UK Department for Environment, Food and Rural Affairs (DEFRA), urging legislation around mandatory reporting, resulting in DEFRA agreeing to reconsider ruling it out.[223,224] In Norway, organisations from industry and retail along with Government ministries signed an agreement on FLW reduction in 2017, with a shift toward binding law becoming likely.[107] Commercial and industrial premises in Singapore has had mandatory waste reporting since 2014 and specific reporting requirements around FLW are coming into effect in 2024.[225]

… a coalition of over 30 major food businesses, including most major UK supermarkets, published an open letter to the UK Department for Environment, Food and Rural Affairs (DEFRA), urging legislation around mandatory reporting…

An important consideration when implementing mandatory FLW reporting, however, is to build in recognition that drivers for FLW often lie elsewhere in the supply chain from where FLW occurs. We know, for example that the highest proportions of FLW occur at either end of the supply chain in production and households, but that retailers often have significant influence over FLW upstream and downstream, while there is a relatively low proportion of FLW that occurs in the retail sector itself (see section 5 of *Preventing food loss and waste In Aotearoa New Zealand: Evidence for action across the supply chain*). Data collected and communicated from mandatory reporting should be carefully designed to capture this.

… the highest proportions of FLW occur at either end of the supply chain in production and households, but retailers often have significant influence over FLW upstream and downstream…

4.2.3 Digitalisation and food loss and waste data infrastructure

While the forthcoming baseline measurement of FLW in Aotearoa will help provide a valuable snapshot, sustainable digital infrastructure for ongoing monitoring of FLW is needed in order to understand the impact of any interventions implemented in the future. An example of this type of infrastructure operating in the US is ReFED's insights engine, which includes functions such as 'Impact Calculator' to quantify a variety of impacts of wasted foods in specific contexts.[217] Ideally, by digitalising the collection of FLW data, the technology will allow us to use this data both immediately to prevent and divert FLW dynamically, as well as longitudinally to help with design and evaluation of policy interventions, initiatives, and infrastructure. One estimate of the impact of digitalising the global supply chain is the aversion of US$1.2 billion of FLW globally each year.[21] Digitalising supply chain data is also a key theme of work being undertaken by MBIE on material flows.[220] Similarly, the

Parliamentary Commissioner for the Environment noted in their 2024 report on resource use and waste generation, that there is an opportunity in New Zealand to establish 'material flows accounts'.[219] Accounts and satellite accounts, is something Stats NZ already has in place for GDP tracking (e.g. tourism is a satellite account of GDP), and could potentially be used as a framework to do the same for material flows such as food and FLW.[226]

Four broad categories of digital technologies that could be explored, and in some cases are already being employed in specific contexts in the food supply chain to measure and monitor FLW have been identified below. Section 2.2 of our report *Preventing food loss and waste In Aotearoa New Zealand: Evidence for action across the supply chain* details wider applications of these technologies for prevention of FLW beyond data collection.

Devices connected to an 'Internet of Things'

A network of connected 'smart' devices, or IoT devices, can provide information that can be acted on by people or can automatically trigger responsive actions within the network.[227] A case study of a ready-meal factory using IoT system architecture for the capture of FLW data in real-time showed a 60.7% reduction in FLW.[114]

Blockchain for managing logistics

Blockchain is a type of distributed ledger technology, which allows all actors in the supply chain to carry out transactions that cannot be altered and is visible across the chain. For example, IBM Food Trust is a blockchain-based platform to track food products from farm to table, enabling suppliers and retailers to identify any safety or quality issues quickly.[228]

Analytics of big data

A digitalised supply chain can collect an abundance of data. This data can offer insight that could improve the operation of the supply chain but must be appropriately analysed to do so. 'Big data' approaches are well suited to this kind of context, and artificial intelligence (AI) could be useful in automating processes or generating insights across the supply chain. One application of such technology is improved demand forecasting, which could more accurately predict demand to minimise overproduction.[229,230] In Germany, for example the use of demand forecasting models in a study of three bakery chains resulted in a 37-89% reduction in FLW.[231]

A platform where data can be stored and shared, and from where data can be accessed, visualised, and analysed.

Better data systems across the supply chain can enable better transparency, risk management and efficiency to reduce FLW through better quality assurance, lower wait times at choke points and less spoilage. An example of such a platform is The Global Data Synchronisation Network (GDSN). This is the world's largest real-time product data network, developed by GS1, to support high quality, standardised data from authoritative sources.[145]

Internationally, governments at various levels are pursuing the creation of platforms for sharing and analysing data. The EU has outlined plans for creating common data spaces in a range of sectors, including agriculture and the 'green deal'.[232] Various projects developing agricultural data spaces have been funded by the Horizon Europe programme, of which New Zealand is an associate member.[233] In Aotearoa, Trust Alliance New Zealand, a not-for-profit industry consortium, is creating a platform for farmers to share data through a digital wallet.[234] To our knowledge, there is not yet a platform that spans the whole food supply chain in New Zealand. Digitalisation across the supply chain is a key opportunity to reduce FLW through improved data and monitoring in the future.

5 Conclusion

FLW is increasingly becoming a key part of the global narrative around sustainable food systems and so needs to be included as a priority for New Zealand businesses aiming for export markets. Domestically, the increasing number of supply chain and climate change related disruptions means we need to ensure robust and resilient food systems. Combatting FLW can also play a significant role in our journey to building resilient local food systems as well as our export based ones.

As is laid out in tables 2, 3, 4, 5, and 6 as well as in our recommendations, there is no shortage of opportunities to work towards an Aotearoa without FLW, such as the one illustrated in our vision. New Zealand's FLW reduction journey is well underway, as is demonstrated in section 1.3, but a more coordinated and strategic approach informed by a data rich evidence base is needed in order to achieve targets such as SDG 12.3, as well as to curtail the environmental, social and economic harms caused by food being lost or wasted. The time is ripe to take a more coordinated and strategic approach to combatting FLW in Aotearoa in order to synchronise the plethora of efforts already underway to ensure effective, systemwide FLW reduction.

Annex 1: Aotearoa's food waste reduction ecosystem map key

Table 8: List of stakeholder logos represented in figure 3. For households and communities, hospitality and food service, retail, manufacturing, and growing: the list is in the order they appear on the diagram from left to right.

	Prevention	Redistribution	Upcycling	Recovery
Households and communities	Resource Wise Programme. Waste-Ed with Kate. Zero Waste Network. Garden to Table. Para Kore. Love Food Hate Waste.	Mahurangi Waste Busters. Kore Hiakai.	N/A	Ecogas. ShareWaste NZ. Food Scraps. Para Kore. Aotearoa Composters Network.
Hospitality and food service	Restaurant Association. Leanpath.	NZ Food Network. Everybody Eats. Foodbank. Foodprint.	Rescued Kitchen. Citizen.	Green Gorilla. City to Farm. Kaicycle. The Compost Collective.
Retail	Kai commitment. Invafresh (Whywaste).	Aotearoa Food Rescue Alliance. NZ Food Network. Foodbank NZ. Foodprint.	Rescued Kitchen.	Ecogas. Ecostock. Envirowaste. EnviroNZ. Aotearoa Composters Network. Mynoke.
Manufacturing	Kai Commitment. Papatūānuku Kōkiri Marae. CiRCLR.	NZ Food Network.	Food Innovation Network. Sustainable is Attainable.	Ecostock. Ecogas. MyNoke. Envirowaste. EnviroNZ.
Growing	Papatūānuku Kōkiri Marae. Te Waka Kai Ora. Kai Commitment.	Perfectly Imperfect. Wonky Box. NZ Food Network. Misfit Garden.	Dermalayr. Biochar Network NZ. Rescued Kitchen.	Animal Feed. Ecostock. Kai Ika. Ecogas.
Evidence-based research	Cawthron Institute. Lincoln University. AgResearch. Callaghan Innovation. Victoria University of Wellington. Bioresource Processing Alliance.			

	Food Waste Innovation Otago. Massey University. Āmiomio Aotearoa. Manaaki Whenua | Landcare Research. Plant & Food Research. Venture Timaru. Sunshine Yates Consulting. Eunomia.
Funding and policy	Ministry for the Environment. Ministry for Primary Industries. Auckland Council. The Tindall Foundation. Whakatupu Aotearoa Foundation.
Design and strategy	The Aotearoa Circle. Kai Commitment. New Zealand Food Waste Champions 12.3. Para Kore. Hua Parakore. Circularity. Kore Hiakai.
Capability building and behaviour change (households)	Love Food Hate Waste. Enviroschools. Waste-Ed with Kate. Garden to Table. Para Kore. The Rubbish Trip. Zero Waste Zero Hunger Challenge.
Capability and behaviour change (industry)	X Labs NZ. Kai Commitment. New Zealand Food Waste Champions 12.3. Eat New Zealand. Aotearoa Food Rescue Alliance. Food & Fibre Centre of Vocational Excellence. A+ NZ Sustainable Aquaculture. Zero Waste Network. Hua Parakore. NZ Food Network. Sustainable is Attainable. Resource Wise Programme. WasteMINZ.

Abbreviations

AD	Anaerobic digestion
AFRA	Aotearoa Food Rescue Alliance
AI	Artificial intelligence
APEC	Asia-Pacific Economic Cooperation
BPA	Bioresource Processing Alliance
CRI	Crown Research Institute
CODC	Central Otago District Council
COP28	UN 28th Conference of the Parties
DEFRA	Department of Environment, Food, and Rural Affairs (UK)
EFWA	End Food Waste Australia
EPA	Environmental Protection Agency
ERP	Emissions Reduction Plan
ETS	Emissions Trading Scheme
FAO	Food and Agriculture Organisation (of the UN)
FLW	Food loss and waste
GDSN	Global Data Synchronisation Network
IRD	Inland Revenue Department | Te Tari Taake
IoT	Internet of things
KPI	Key performance indicator
LCA	Life cycle assessment
MBIE	Ministry for Business, Innovation and Employment | Hīkina Whakatutuki
MERI	Monitoring, evaluation, reporting, and improvement
MfE	Ministry for the Environment | Manatū Mō Te Taiao
MoE	Ministry of Education | Te Tāhuhu o te Mātauranga
MoH	Ministry of Health | Manatū Hauora
MOU	Memorandum of understanding
MPI	Ministry for Primary Industries | Manatū Ahu Matua
MSD	Ministry for Social Development | Te Manatū Whakahiato Ora
NZFN	New Zealand Food Network
NZFWC	New Zealand Food Waste Champions 12.3

OECD	Organisation for Economic Cooperation and Development
PCE	Parliamentary Commission for the Environment
PFAS	Per and poly-fluoroalkyl substances
PKE	Palm kernel expeller
QR	Quick response (as in QR code)
R&D	Research and development
RFID	Radio frequency identification
SAP	Sector action plan
SDG	Sustainable Development Goal
SFF	Sustainable Food and Fibre
SME	Small and medium enterprises
SROI	Social return on investment
TA	Territorial Authority
UNEP	UN Environment Programme
UoO	University of Otago | Ōtakou Whakaihu Waka
WRAP	Waste and Resources Action Programme (UK)
WWF	World Wildlife Fund

Glossary

2D barcode	A graphical image that stores data in two dimensions (vertically and horizontally), e.g. a QR code. In the food supply chain, these codes are used to store product information and improve product traceability and inventory management.
Aotearoa New Zealand	The terms Aotearoa New Zealand, Aotearoa, and New Zealand are used interchangeably in this report.
Circular economy	A sustainable approach to resource use where waste and pollution are viewed as design flaws, products and materials are kept in use as long as possible, and nutrients and energy are captured at the end of a product's life to regenerate natural systems.
Compost and composting	A nutrient rich material used as soil, made from broken down food and other organic matter. Composting is the specific biological process that occurs to create this soil.
Cosmetic specifications	Specific requirements for fruit and vegetables regarding their colour, size, and shape. Produce must meet these specifications in order to be considered marketable.
Digitalisation	Converting operations and processes from analogue to digital.
Downstream	Parts of the food supply chain that are closer to the consumer end relative to the part of the supply chain being discussed. For example, retail is downstream of processing and manufacturing (also see upstream).
Energy recovery	Capturing the energy held in FLW so that it can be used to generate heat or electricity, or as a fuel or natural gas equivalent.
Export	Food or food products that are produced in one country and sold in markets in other countries. In this report, we mostly refer to exporting food from New Zealand.
Feedstock	Material that feeds nutrient and energy recovery processes e.g. food scraps are a feedstock for composting and AD.
Food	In this project, food is intended to capture both food and beverages. Unless specified, we are referring to food intended for human consumption.
Food by-products	Materials, both edible and non-edible, that are produced as secondary products during the production and processing stages of the food supply chain. Food by-products are not the primary targets of production but are nonetheless generated as part of the process, e.g. grape marc or bran.
Food lifecyle	The entire journey of food products from their origin in agriculture or production, through processing, packaging, distribution, consumption, and finally disposal or recovery.
Food loss	Food that is discarded during the production or processing stages of the supply chain. Food discarded after this stage (i.e. in retail, food service, and household settings) is referred to as food waste.

Food loss and waste	For the purposes of this project, FLW is defined broadly and inclusively as any food or drink that isn't utilised according to its original purpose, as well as by-products and that non-edible components of food are included. We give regard to the variable understandings of food and food waste. The entire supply chain is in scope.
Food recovery hierarchy, also referred to as 'the hierarchy'	A framework for thinking about solutions to FLW, prioritising interventions according to which types of solutions are likely to deliver the most environmental and social good. The food recovery hierarchy is a modified version of the waste management hierarchy, specific to food. There are many different versions of the food recovery hierarchy. Also known as the 'food waste hierarchy' or the 'food waste management hierarchy'.
Food rescue	The process by which surplus food is captured for human consumption, typically as part of a charity model – but this isn't inherent in the term.
Food service	A part of the food supply chain that prepares food for immediate consumption on-site, takeaway, or delivery, e.g. restaurants, catering services, and cafeterias.
Food security	All people at all times, having physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy lifestyle. Food insecurity is the negation of this.
Food supply chain	The pathway from where the raw ingredients that will become our food originate, to the places where we eat, form the food supply chain. Specific pathways differ for different kinds of food.
Food system	While food supply chains are a part of food systems, food systems is a more holistic term. The OECD definition of food systems captures the meaning well: "Food systems refers to all the elements and activities related to producing and consuming food, and their effects, including economic, health, and environmental outcomes."[235]
Food waste	Food that is discarded after the processing stage of the food supply chain, i.e. in retail, food service, and household settings. Food discarded in the production and processing stages of the supply chain is referred to as food loss.
Grape marc	The solid residue left behind when grapes are processed during wine making. Grape marc contains skins, stalks, and moisture, as well as organic acids and polyphenols (including tannins), sugar residues, and alcohol.
Intervention	A deliberate action or set of coordinated actions designed to change specific behaviours or practices to achieve a particular outcome. In this report, we focus on interventions which aim to prevent FLW.
Manufactured or manufacturers	Involves machinery, automation, and assembly lines to produce packaged foods like snacks or ready-to-eat meals. Manufacturers are the actors who carry out manufacturing.
Mastitis	Mastitis is an inflammation of the mammary gland, commonly associated with lactating animals, including dairy cows, goats, and sheep.

Material recovery	The use of inedible components of food at risk of going to waste to produce useful materials, such as fibre-based packaging.
Nutrient recovery	Capturing nutrients from FLW so that they can be used in agricultural systems, gardens, and to regenerate natural environments.
Overproduction	In this report, we are referring to the overproduction of food. This is when the volume of food produced far exceeds the demand in the market. This usually occurs as a strategy to avoid risk. See section 1.2.1 for a full explanation.
Packhouses	These are sites of post-harvest sorting and grading of produce. Depending on the industry and the size of the operation, packhouses may be located on farms or at a secondary location. Packhouses are considered part of the production stage of the supply chain (also see post-harvest).
Palm kernel expeller	A by-product of palm oil production, used in Aotearoa as a feed supplement for dairy cows.
Plate waste	Food that is served to consumers but that is not eaten. Plate waste can occur both in food service and in households.
Post-harvest	This is a sub-stage of the supply chain within production. During post-harvest, produce is sorted and graded, often in packhouses (also see packhouses).
Preparation waste	Food that is discarded during the preparation of food for sale (in food service) or consumption (in households).
Processed and processors	Any modification to food including the removal of inedible parts or the addition of other ingredients, and transformation of ingredients into food products. Processors are the actors who carry out the processing.
Producers	People that use natural resources including land, water, seeds, animals, to cultivate, breed, or harvest food or ingredients of food. Producers are also known as farmers or growers.
Production	The first stage of the food supply chain, where food is grown and harvested (i.e. farming, growing, aquaculture, hunting, fishing, gathering etc.). Production includes pre-harvest, harvest, and post-harvest activities.
Quality specifications	The set of criteria that food products must meet to ensure they are suitable for consumption, sale, or further processing and maintain food safety across the food industry. Specifications can vary by food type and regulatory requirements, but typically include physical attributes (e.g. size, weight, colour), safety standards (e.g. pesticide residues or microbiological limits), chemical composition (e.g. nutrient or moisture content), and sensory characteristics like taste, texture, or aroma.
Rendering	A process that converts waste animal tissue to value-added, more stable materials, e.g. processing raw fat to lard.
Retailers	Businesses that sell food products directly to consumers. This can include a variety of outlet types, from large supermarket chains and specialty food stores to local grocers, farmers' markets, and online food retailers.

Secondary market	A marketplace where food products, which are not sold through primary channels (typically retailers), find a different route to consumers. This can include, but is not limited to, overstocked, returned, imperfect, or near-expiration products that are still safe and usable but may not meet the primary market's stringent criteria for aesthetics or quality.
Spoilage	Food that is unfit for human consumption due to damage or deterioration.
Suboptimal food	Suboptimal food is an umbrella term which describes food that consumers perceive of lesser value than other items of the same kind. Foods can be considered suboptimal for a variety of reasons: they're nearing their indicated date; they deviate in appearance (i.e. imperfect produce); or their packaging is damaged.
Surplus food	Quality, safe, edible food that exceeds the need or demands of a population and is at risk of being wasted if it isn't used. It is distinct from food that is spoiled, damaged, contaminated, past its use-by date, or otherwise no longer fit for human consumption.
Te taiao	Māori concept of the environment, encompassing an integrated view of natural and physical resources.
Terms of trade	In this context, these are the conditions and agreements under which trade is conducted between parties involved in the procurement, production, and distribution of food.
Territorial authority	This is a term for local governments, including city and district councils. There are 67 territorial authorities in New Zealand.
Upcycling	Keeping food at risk of going to waste in the human food supply chain by creating new food products from by-products or unmarketable foods such as stale bread, offcuts, or damaged produce.
Upstream	Parts of the food supply chain that are closer to the production end relative to the part of the supply chain being discussed, e.g. processing and manufacturing is upstream of retail (also see downstream).
Valorisation	Adding value to or capturing value from food that otherwise would have gone to waste (e.g. landfill) or would not have been used to its full potential. Valorisation can be achieved through technical solutions (e.g. processing by-products into edible foods) or a reimagining of food at risk of going to waste (e.g. expanding the cosmetic standard specifications from fresh produce).
Vermicomposting	The technical name for worm farming.
Wholesaler	An intermediary business in the food supply chain that purchases large quantities of food from producers or manufacturers and sells them on in smaller quantities to retailers, other wholesalers, or food service providers.

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