



A Literature Review of Interventions to Reduce Household Waste

Kathryn Ovenden, Jesse Allpress, Ashleigh Prakash

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Kathryn Ovenden

Dr Jesse Allpress

Dr Ashleigh Prakash

Research and Evaluation Unit (RIMU)

Auckland Council

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Executive summary

This literature review explores interventions that aim to reduce waste to landfill, with a focus on food waste. Auckland Council's Waste Management and Minimisation Plan aspires to achieve zero waste by 2040¹. The council's Community WasteWise team funds a significant amount of community-based waste reduction activity in service of this goal.

In 2022, Auckland Council's Research and Evaluation Unit (RIMU) was commissioned by the WasteWise team to undertake an evaluation to understand the outcomes associated with WasteWise initiatives and to improve the effectiveness of the programme of work. Results of that evaluation are presented in a separate document.²

The team also sought to better understand how behavioural insights could be used to inform the initiatives they support. This literature review meets this objective and has been written to complement the WasteWise evaluation, as well as to stand alone for others working to encourage waste-reduction. This review considers non-regulatory approaches to reducing household waste that targets consumers with a focus on interventions related to food waste.

The review found a wide range of intervention types have been tested and many are information-based or used information as a component of an intervention package. These information-only interventions tend to have low effectiveness at changing behaviour.

Effectiveness appears to improve when information is paired with other types of interventions. Examples of effectiveness-enhancing approaches include:

- providing timely prompts
- modifying the household environment to make desirable behaviours easier to perform
- providing personalised feedback on waste production
- personalised coaching that draws on behavioural research to provide tailored solutions to barriers experienced by households
- eliciting commitments
- using positive descriptive norms.

Despite the above findings, there are still many gaps in knowledge of what works most effectively. The application of behavioural insights and the use of behaviour change frameworks to inform development of interventions are recommended as an approach to overcome these knowledge gaps. Two frameworks are suggested for use: COM-B model (Capability, Opportunity, Motivation, Behaviour), and EAST framework (Easy, Attractive, Social, Timely).

¹ Waste Management and Minimisation Plan is available at: <https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/topic-based-plans-strategies/environmental-plans-strategies/docs/wastemanagementplan/auckland-waste-management-minimisation-plan.pdf>

² *Evaluation of the Auckland Council Community WasteWise programme of work*. Auckland Council technical report, TR2023/1

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1. Introduction

Every year, more than 1.6 million tonnes of waste are sent to landfill in Tāmaki Makaurau Auckland. Auckland Council has set an aspiration for Auckland to achieve zero waste by 2040, as outlined in Auckland Council’s Waste Management and Minimisation Plan 2018 (WMMP).³ Council’s Community WasteWise team funds a significant amount of community-based waste reduction activity in service of this goal. In 2022 the WasteWise team commissioned Auckland Council’s Research and Evaluation Unit (RIMU) to evaluate the impact of their current work programme.

This review has been written to complement the WasteWise evaluation report.⁴ It meets the WasteWise team’s aim to better understand how behavioural insights could be used to inform the initiatives they support. This rapid literature review has two objectives:

1. To review interventions aiming to reduce waste to landfill, that could be adopted by Auckland Council and its community partners. This includes only non-regulatory approaches to reducing waste targeting consumers.
2. To demonstrate the application of behavioural insights frameworks in the development of interventions, that could also be utilised by Auckland Council and its community partners.

1.1 Review method and scope

The literature review took a rapid review approach with no use of scoring or exclusion criteria based on method or data quality. The literature search was conducted in June-July 2022 using Google Scholar.

Google Scholar keywords included: behaviour change, behavioural insights, composting, food waste, intervention, kerbside recycling, recycling, reduce waste to landfill, residential, trial.

Where articles of interest were identified through Google Scholar, the first four pages of results were searched. The ‘related articles’ and ‘cited by’ features were also utilised in sourcing literature.

The following parameters guided the review:

- Focused primarily on publications since 2010
- Inclusive of non-regulatory interventions delivered by government, community groups, or interventions developed for the purpose of academic trials
- Published in the English language

³ <https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/topic-based-plans-strategies/environmental-plans-strategies/Pages/waste-management-minimisation-plan.aspx>

⁴ *Evaluation of the Auckland Council Community WasteWise programme of work*. Auckland Council technical report, TR2023/1

- Studies conducted in Western countries, similar in culture to New Zealand
- Residential settings of different typologies (e.g. apartments, standalone houses) including social housing, university residences. Urban, suburban and rural areas.

The literature review included peer-reviewed journal articles, grey literature (e.g. government reports), and theses/dissertations. Both studies and review articles have been included.

Literature included in this review is focused on behavioural interventions trials that aim to measure behaviour. Much of the literature surrounding reducing household waste is focused on awareness or attitudes⁵. Some of this literature assumes awareness/attitudes is indicative of behaviour. However, the attitude-behaviour, awareness-behaviour and intention-behaviour gaps evidence the inappropriateness of this assumption (Kollmuss & Agyeman, 2002).

1.2 Literature on delivery by community partners

Auckland Council's WasteWise team delivers many waste reduction initiatives through community partners. No peer reviewed studies were found to collaborate with community partners in their delivery of interventions or evaluation of intervention impact. Comment cannot be made on the efficacy or appropriateness of the interventions included in this review for delivery with community partners as a result.

The European Commission funds FUSIONS (Food Use for Social Innovation by Optimising Waste Prevention Strategies), a network of social innovation organisations, who deliver programmes aimed at reducing food waste at the intersection between retailers (i.e. places that sell direct to customers such as supermarkets) and households. As these interventions did not occur in residential settings, they are deemed out of scope for this review⁶.

1.3 The waste system

Waste is generated and disposed of within a complex system. Interventions to reduce waste can intervene at many points in this system and will have varied impacts. In manufacturing, products can be packaged in ways to reduce waste (e.g. minimal packaging) and reduce waste to landfill (e.g. compostable packaging). In retail and logistics, product stocks can be managed to reduce waste. The consumption choices, household food management, and waste management of consumers all impact waste. For example, 40 per cent of food waste is reported to occur at the end of the food chain by consumers in developed countries (Zeinstra et al., 2020). However, which part of the system is the largest contributor of food waste is debated. An Australian study reports that retailers may be the greatest food waste contributor,

⁵ For example see: <https://lovefoodhatewaste.co.nz/wp-content/uploads/2016/03/Online-Survey-of-attitudes-to-food-waste-.pdf> and <https://lovefoodhatewaste.co.nz/wp-content/uploads/2019/02/FINAL-WasteMINZ-National-Food-Waste-Prevention-Study-2018.pdf>

⁶ A series of feasibility studies were undertaken and reports available at <http://www.eu-fusions.org/index.php/social-innovations/fusions-feasibility-studies>

and claims deficient corporate social responsibility and power resulting from the retailer duopoly are key causes of waste (Devin & Richards, 2018).

Consumers can face a power disadvantage that limits their ability to reduce waste relative to other actors in the system (e.g. retailers, manufacturers) (Devin & Richards, 2018).

Consideration should therefore be given to the power dynamics within the waste system to ensure interventions are equitably delivered and do not place undue responsibility on consumers⁷.

1.4 Behaviours

The original scope for this review included three behaviour areas: avoiding food waste, dry recycling, and home composting. Due to a lack of literature surrounding dry recycling and home composting, the focus of this review is avoiding food waste. The three original areas of behaviour are briefly outlined below including comment on the state of relevant literature.

Avoiding food waste

This review found there to be a large body of interdisciplinary literature focused on avoiding food waste. Household food waste results from a household acquiring more food than is consumed.

There are many complex behaviours involved in the generation and reduction of food waste (Bretter et al., 2022; Geffen et al., 2020; van der Werf et al., 2021). These can include:

- meal planning
- shopping lists
- grocery shopping
- correct food storage
- estimating food safety
- comprehension of food labels (such as 'best before' and 'use by')
- eating leftovers.

The sequencing, frequency of performance, contribution to food waste, and attitudes towards these behaviours can vary (for detail on behaviours see (Hebrok & Boks, 2017; Quested et al., 2013).

The review found different terms to describe this collection of behaviours including 'household food management' (Geffen et al., 2020), 'food management behaviours' (Bretter et al., 2022), and 'food literacy' (van der Werf et al., 2021). Behavioural interventions can target one or more food management behaviours.

⁷ Further strategic context of waste in Tāmaki Makaurau can be found in *Evaluation of the Auckland Council Community WasteWise programme of work* Auckland Council technical report, TR2023/1

Composting

We found significantly less literature focused on residential composting compared with other activities to address food waste. A systematic literature review published in 2021 identified only seven composting intervention trial publications between 1995-2020 (Sewak et al., 2021). Two of these articles were published in Western countries after 2010 – one of which was focused on the importance of convenient food scraps bin placement in a multi-family residence (DiGiacomo et al., 2018), and so was not deemed to be in scope. The other was cited as evaluating a home composting awareness campaign; however, the article describes a door knocking survey that collected information about composting motivations and compost bin use (Karkanias et al., 2016). As no intervention was ‘trialled’ in this article, it is also out of scope.

In the United States, the focus on diverting food waste has been on industrial and commercial sectors, or employs kerbside collections of food waste to organic waste treatment facilities (Pai et al., 2019). Studies on backyard composting in the United States cited by Pai et al., (2019) were all published prior to 2002, suggesting this may not be an active area of academic enquiry. Several case studies were found for collection of food scraps in Sweden (Bernstad, 2014; Bernstad et al., 2013) and England (Shearer et al., 2017). Two New Zealand studies were found to have grey literature reports: Create Your Own Eden (Longdill, 2012) and Para Kai Miramar Peninsula Trial (GravitasOPG, Unknown).

Recycling

There are several behaviours involved in ‘dry’ recycling (i.e. recycling of cardboard, glass, hard plastics, metal) such as distinguishing recyclables from other refuse, preparing items (e.g. cleaning), correctly placing items in the right bin, and taking the bin to the collection point (e.g. kerbside, collection centre, bin room) (Varotto & Spagnolli, 2017). Compared with food waste, there is less recent literature focused on recycling which may be explained by recycling having been a normative behaviour in many Western countries for some time.

2. Intervention case studies

This section is organised by three categories of interventions and contains examples for each. A large portion of the available literature is focused on information-based interventions – these are discussed first. Interventions can combine information with something else, such as with a prompt or a commitment – these are discussed next. Finally, there are interventions that have minimal reliance on information such as smart technology, tools (e.g. measuring cups) and skills (e.g. cooking classes). In each section, a summary of interventions is provided followed by selected case studies.

2.1 Information-based interventions

Information-based interventions are a commonly used approach that tend to focus on informing the audience about the negative consequences of a behaviour (e.g. rubbish in landfill) and benefits of prevention (e.g. cost savings). These interventions aim to increase awareness as a step towards behavioural change (Quested et al., 2013). Some such interventions include instructions to increase abilities such as how to plan a meal, estimating food safety, sorting and preparing recyclables, and food storage techniques (Geffen et al., 2020). Information-based interventions are often found to be insufficient to result in behaviour change alone and to become successful need to be paired with other interventions (e.g. prompts and commitments) (Nisa et al., 2022; Stöckli et al., 2018).

Information-based interventions contain a lot of variation across content, tone (positive/negative) and design elements (colour, font, accessibility), which may all influence effectiveness. Most studies do not acknowledge this variation and make no attempt to examine the impact of designs or content. Nisa et al. (2022) examined different messages and is the only study found to assess the impact of different designs. It is recommended that information-based interventions employ the expertise of designers in their development.

Information-based interventions were found to have similarities and findings across these can be generalised. Some of these generalised findings are also applicable to ‘more than information’ interventions such as fridge magnets which can contain information, and act as a prompt. A summary of findings across example interventions is provided first. Following on is a table containing examples of information-based interventions and provides evidence of their effectiveness. Some key implications for the design of interventions are also included. Finally, some selected case study examples are provided in detail.

Information alone is often insufficient to result in behaviour change, but can become effective when paired with other interventions and optimised by applying the following:

- **Apply descriptive social norms:** Descriptive social norms describe beliefs surrounding others behaviour and are found to strongly influence behaviour (Geffen et al., 2020).

- **Use economic motivators with caution:** The personal financial cost of food waste can evoke feelings of guilt and is reported as a greater motivator for waste prevention compared with environmental or social impacts (Stancu et al., 2016). However, the economic impact of food waste is competing with other priorities (e.g. being sociable, health) and will not always result in waste reduction behaviours (Shaw et al., 2018).
- **Use polite language:** More imperative messages (e.g. 'stop food waste') are likely less effective as they produce psychological resistance. Polite, persuasive messages (e.g. 'reduce food waste') are more effective, potentially as they are perceived to be less authoritative (Nisa et al., 2022).
- **Are simple** or provide information in 'chunks' (websites are capable of chunking information better than printed material). Detailed information can result in cognitive overload and disengagement (Nisa et al., 2022; Wharton et al., 2021).
- **Require no prior knowledge to be understood:** Witty slogans are often difficult for diverse audiences to comprehend (Bernstad, 2014).
- **Demand audience attention** through an eye-catching design and delivery mechanism. For example, unaddressed items in mailboxes are frequently treated as junk mail and thrown away (Bernstad, 2014).
- **Are focused on instructions rather than explanations:** Instructional information about how to perform a behaviour is more effective than explanations about why waste is an issue, especially for those aware of the issue (Wharton et al., 2021).

The table below summarises a selection of information-based interventions including evidence for their effectiveness on evoking behaviour change, the amount of evidence in literature (low, medium, or high determined by number of studies included in this review and application of the intervention in other contexts), and finally implications for the WasteWise team.

Intervention	Evidence for effectiveness	Amount of evidence	Implications
Door knocking	Oral information can be considered more effective than printed information due to the interpersonal delivery, but door knocking can be expensive to implement and face low contact rates (Varotto & Spagnolli, 2017). Delivering oral information about separating food waste by door knocking was found to not reduce food waste (Bernstad et al., 2013).	Medium	X Door knocking is labour intensive and expensive X Don't pursue door knocking campaigns, unless new evidence emerges for their effectiveness ⁸

⁸ Note, at the time of publishing this evaluation the WasteWise team was conducting a randomised controlled trial on interventions to encourage food scraps service use, which included a door knocking condition.

Intervention	Evidence for effectiveness	Amount of evidence	Implications
Social media	The effectiveness of social media campaigns is challenging to determine. One study found those who had seen a social media campaign had reduced their food waste; however, this reduction was also reported by those who had not seen the social media campaign (Young et al., 2017).	Medium	<p>✗ Don't pursue social media campaigns as a primary intervention</p>
Pamphlets / brochures / postcards	Pamphlets are frequently used in combination with other interventions and few studies utilise them as a primary intervention. In a study that used pamphlets alongside other interventions, the pamphlet containing information about food waste recycling and its importance was found to have no impact on quantities of food waste (Bernstad, 2014).	High	<p>✗ Don't pursue pamphlets delivered to households as a primary intervention</p> <p>✗ Don't use slogans that require prior knowledge to understand</p> <p>✗ Don't deliver to mailboxes as will be treated as junk mail</p>
Educational website	A study trialled a multifaceted educational website with strategies for food waste reduction (Wharton et al., 2021). Module content included recipes to use kitchen scraps and about-to-spoil foods; shopping tips; food storage guides and pantry organisation; understanding expiration dates and food safety; freezer use and packing food properly. Content available at: https://sustainability.asu.edu/waste-watchers/ . The website was found to be effective at reducing household food waste by 28% (compared to baseline).	Low	<p>✓ Explore delivery of educational website content</p> <p>✓ Focus content on instructions (how-information) rather than consequences of food waste (why-information)</p> <p>✗ Detailed websites can result in information overload and disengagement</p>

Intervention	Evidence for effectiveness	Amount of evidence	Implications
Mass media campaign	The Love Food, Hate Waste campaign focuses on raising awareness, benefits of reducing food waste (economic and environmental) as well as increasing knowledge and skills. Cause and effect conclusions on mass media campaign are not possible; however, household food waste in the UK has lowered since the campaign launched in 2011 (Quested et al., 2013).	High	✓ Awareness building campaigns can be a useful first step towards reducing food waste
e-newsletters	An e-newsletter sent to members of a supermarket loyalty scheme self-reported a 19% reduction in self-reported food waste (Young et al., 2017). E-newsletters used as part of a package were found through focus groups to be unread, but were perceived to act as a reminder (Soma et al., 2021).	Medium	✓ e-newsletters can act as a reminder ✗ Don't rely on the content to have an impact
Community workshops and courses	Workshops part of the Love Food Hate Waste campaign in the UK provided information on food management. These were found to reduce avoidable food waste by up to 50% compared with baseline (Yamakawa et al., 2017). However, another study recruited 144 participants to attend a series of four workshops (similar to Love Food Hate Waste workshops). Only nine participants attended at least one workshop and completed the post-intervention survey (Soma et al., 2020). This study found no significant differences found in edible food waste between workshop and control group in waste audit. See case study for more details. Create Your Own Eden delivered courses about composting (Longdill, 2012). Prior	Low	~ Mixed results. Attendance at dedicated workshops may be low resulting in a poor ROI. Higher attendance might be achieved through workshops delivered at meetings of existing groups (e.g. gardening clubs). ~ Impact may be reliant on workshop collateral. ~ Workshops likely to be attended by those already

Intervention	Evidence for effectiveness	Amount of evidence	Implications
	to attending the course, 69% of participants were fully or partially composting kitchen scraps. 16% of participants were not composting prior to attending the course and were composting 2-months after the course. The remaining 15% of participants were not composting prior to the course and were also not composting 2-months after the course.		engaged in the behaviour.

Assessing the effectiveness of food waste messaging (Nisa et al., 2022)

Study design: Experimental between-subjects design, self-reported willingness to behave captured in survey.

Interventions trialled: Interventions based on those used by US Environmental Protection Agency, United Nations Food and Agricultural Organizations, and Love Food Hate Waste.




Study	Examples of messages tested per study
Study 1. Quick Prompts	
Study 2. Consequences of food waste	
Study 3. Bundled messages	

Fig. 1. Summary of studies and examples of type of messages tested per study. Note: Further details on messages used are presented in Appendix A.

Study findings: Quick prompt “reduce waste” effective in increasing willingness to change food waste behaviour.

Consequences of food waste had no effect on willingness to change behaviour – not significantly different to control group.

Bundled messages had mixed results – single stimulus message had greatest increase in willingness, two or more messages had less.

Implications for WasteWise team:

- Provision of more information in the form of bundled messaging does not necessarily result in reduced food waste because of cognitive overload → Keep It Simple.
- More imperative messages (e.g. ‘stop food waste’) are ineffective as they produce psychological resistance. Persuasive messages (e.g. ‘reduce food waste’) are more effective potentially as they are perceived to be less controlling/authoritative.
- Messaging alone may not be an effective approach and alternative intervention types are needed.

An Evaluation of a Consumer Food Waste Awareness Campaign using the Motivation Opportunity Ability Framework (Soma et al., 2021)

Food Waste Reduction: A Test of Three Consumer Awareness Interventions (Soma et al., 2020)

Study design: 90min qualitative focus groups 3-months following trial end (described in 2021 publication). Pre- and post-intervention surveys (described in 2020 publication). Applies the MOA framework, which is very similar to the COM-B framework described in Section 3.2.

Interventions trialled: 12-week campaign based on Love Food Hate Waste and Food: Too Good to Waste content. Multiple intervention groups: information only, community engagement + information, and gamification + information. Also a control group who received no intervention.

Information only was a booklet (see below) in addition to newsletters, and a food storage fridge magnet intended to act as a prompt (see below).

Community engagement received invitations to four 1-hour learning workshops with presentations on how to reduce waste at home, discussions, activities and prizes.

Workshops were similar in content to those delivered by Love Food Hate Waste.

Gamification group were invited to play a weekly online trivia game (see sample question below). They earned 10 points each week they participated and were rewarded with grocery gift cards.

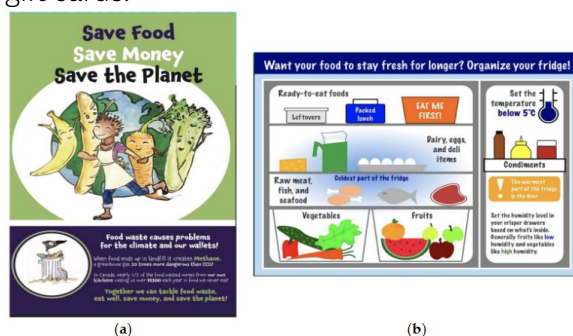


Figure 1. Informational booklet (a) and fridge magnet (b).

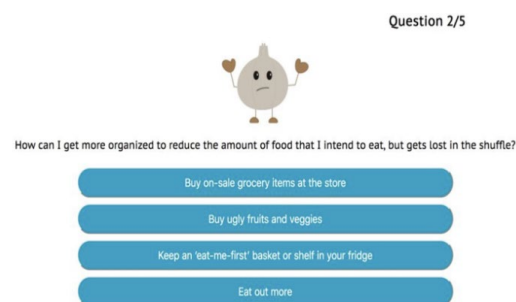


Figure 2. Sample online game question.

Survey findings:

Attendance at workshops was very low and so this treatment group's survey responses were unable to be compared with other groups.

Self-reported decreases in food waste for both the information and gamification group were significantly greater than the control group (and not significantly different to one another). This suggests both interventions were equally successful in achieving a reduction in food waste.

Self-reported awareness of food waste for both the information and gamification group were significantly greater than the control group (and not significantly different to one another). This suggests both interventions were equally successful in achieving an increase in food waste awareness. 44% of the control group also reported an increase in awareness without receiving any intervention. This could be the result participation in a study of food waste.

(summary box contd.)

Focus group findings:

- Attendance at workshops was very low and some explained this was due to time scarcity/a conflict in scheduling and information fatigue.
- For some participants, the volume of education materials was overwhelming and resulted in their disengagement. However, even when the material was not read, receiving the newsletter acted as a reminder to consider food waste for some.
- The gamification group had the highest engagement (61% of participants completed all 12 weeks of quizzes) and noted that it was quick, simple, and fun as reasons for their continued engagement. This group were also motivated by gift card incentive to participate. Other studies have found financial incentives have a small positive and ongoing effect on behaviour after their removal and question their ability to be scaled up due to cost.
- Designing interventions targeting the 'opportunity' component of the MOA framework are challenging. Reminders and visual prompts (e.g. fridge magnets) are seen to be the best available options when changing structures, materials, or systems are unachievable. Participants responded positively to fridge magnet prompt as it gave instructions on how to best organise the fridge. Given that it is likely to be located on the fridge, the proximity of the prompt to the place of behaviour performance is assumed to have contributed to its success.
- Organic waste bins diminish guilt felt by participants over food waste because it is seen to be a positive environmental action (compared with landfill disposal), and consequently may encourage food waste.
- 'Ability' component of MOA was the strongest area of improvement. An aspect of ability highlighted is the challenge of multiple people in a household involved in food management. This is as exemplified in the quote below:

My partner is more impulsive with buying things at the grocery store. And so for me, when I go, I just get exactly what we know that we need and I won't overbuy, but my partner may see a really fancy cheese or something that would just end up sitting in the fridge and maybe we will have to throw it out. So the easiest thing is to shop alone. The hardest thing [referring to reducing food waste] is to control my partner.

Implications for WasteWise team:

- Avoid information overload → leads to disengagement.
- Use fridge magnet prompts → concise information, visually appealing, contains instruction located where behaviour is performed (the fridge).
- Organic waste bins may encourage production of more food waste.
- Households are not necessarily unified or homogenous units → added complexity when designing interventions.
- Awareness campaigns are one of several tools and should be used in tandem with other approaches.
- People's capacity to actively engage in food waste is very low. Interventions cannot require a block of time (e.g. workshops) or pages of reading (e.g. booklets, newsletters). Short, timely, fun interventions (e.g. quiz) better match available capacity.
- Refer to supplementary information (e.g. tables of edible and inedible food waste items) for assistance in designing a food waste trial. Recommend approach of complementing trial (survey and waste audit) with qualitative data collection.

2.2 More-than-information interventions

Information-based interventions described in the previous section can be combined with other components such as tools, commitments, or prompts. This combination approach tends to have a greater impact on behaviour than information alone. Commitments combined with information, for example, have been demonstrated to reduce food waste (Schmidt, 2016). The combination approach can make it challenging to determine which parts of the intervention are having an effect, making evaluating impact difficult.

The table below includes examples of interventions that employ information alongside other components. As with the previous section, evidence of their effectiveness and implications are noted. Selected case study examples containing more detail follow on.

Intervention	Evidence for effectiveness	Amount of evidence	Implications
Prompts such as stickers or magnets	<p>Looking across studies that have trialled prompts, there are contexts in which they work well and design considerations to optimise their effectiveness, including:</p> <ul style="list-style-type: none">• Prompts work best for people who already intent on changing their behaviour and are unlikely to have an impact on those unaware (Geffen et al., 2020)• Place prompts in a location where the behaviour takes place (e.g. stickers affixed to refuse bins to encourage separation of food waste from landfill found to have a significant impact (Shearer et al., 2017))• Prompts should only be used to address a behaviour that is easy to perform (Stöckli et al., 2018)• Prompts containing instructions (e.g. fridge organisation (Soma et al., 2021)) are more impactful than a generic message (e.g. ‘don’t throw away food!’ (Rohm et al., 2017)).	High	✓ Explore delivery of prompts

Intervention	Evidence for effectiveness	Amount of evidence	Implications
Information and tool package: magnet, postcard, website, food storage container, grocery list pad	Package of information and tools resulted in a 31% reduction in food waste compared with baseline (van der Werf et al., 2021). See case study for more details.	Medium	✓ Explore multi-component interventions
Tailored coaching delivered by smartphone technology	Coaching using a 'behavioural toolbox approach' found to reduce plate waste by 79% and reduce food to landfill by 24%. Coaching had no impact on food purchasing or clean-out behaviours. (Roe et al., 2022). See case study for more details.	Low	✓ Explore delivery of tailored coaching using a behavioural toolbox approach
Online quiz to produce personalised recommendations and requests a commitment	Study found an improvement in self-reported performance of food waste reducing behaviours compared with the control group (Schmidt, 2016).	Medium	✓ Explore delivery of commitments
Personalised feedback letters	Letters providing information about the amount of recycling compared with other households was found to increase recycling by 3.4 percentage points (Milford et al., 2015). See case study for more details. Combining descriptive social norms with feedback (through the delivery of postcards reporting on food waste recycling compared with neighbours) reduced food waste in the treatment group compared with control group (Nomura et al., 2011).	High	✓ Explore the delivery of personalised feedback
Workshops and collaborative	Engagement approach of inviting social housing residents to attend a workshop	Low	✓ Explore approaches

Intervention	Evidence for effectiveness	Amount of evidence	Implications
revision of waste management	and subsequently work with the project team to deliver waste management on site by, for example, rearranging the bin room, installation of a composter, and signage (Woodard & Rossouw, 2021). See case study for more details.		<p>that can empower residents to manage their waste collection</p> <p>~ Approach may only be applicable to housing developments with communal waste facilitates, more research needed</p>

“Reduce Food Waste, Save Money”: Testing a Novel Intervention to Reduce Household Food Waste (van der Werf et al., 2021)

Study design: Randomised controlled trial with a control and treatment group. Pre- and post-rubbish samples compared by researchers collecting kerbside rubbish, manually sorted and weighted. Pre-survey with 71 items to inform intervention design.

Interventions trialled: Food literacy package delivered to homes. Pack came in a 4L food storage container and included a postcard and fridge magnet (same design, pictured on right), freezer stickers, grocery list pad, and purpose-built website (<http://www.foodwaste.ca/>) with food waste tips. Over the two-week trial period, five encouraging emails were sent with links to the website.



Study findings:

Participants stated motivation for reducing food waste was economic rather than social or environmental. This insight was used to inform intervention design focused on ‘save money’.

Total food waste decreased by 31% (just over 1kg/household) in treatment households, significantly greater than control group. Avoidable food waste decreased by 30% (634g/household) in treatment households. Key determinants for reduction in food waste include personal attitudes, perceived behavioural control, household size, total amount of garbage put out for collection.

Implications for WasteWise team:

- The reported effectiveness of economically motivated messaging across different studies is mixed and should be applied with caution.
- It is unknown which individual or combination of components in the package were effective at reducing food waste. Take care when designing multi-component interventions.

A Randomized Controlled Trial to Address Consumer Food Waste with a Technology-aided Tailored Sustainability Intervention (Roe et al., 2022)

Study design: Participants used FoodImage app to document food over 7 days (including shopping, consumption, preparation, clean-outs). After 7 days, randomly assigned to control or treatment group (continued to document food in app). Treatment group met with coach who interviewed about lifestyle, then set SMART goals and tailored techniques to reduce food waste. Participants received tailored tips via txt message and followed up with coach to adjust techniques and provide encouragement. Control group had similar process with a coach, however, this coaching was focused on stress management, not reducing food waste.

Interventions trialled: Technology-aided tailored sustainability interventions (TATSIs), a version of 'Tailored Lifestyle Interventions' which involve trained counsellors developing personalised strategies to change behaviour. Counsellors tailored strategies using a 'behavioural toolbox' approach that included 160 food waste drivers (based on COM-B model described in Section 3.2) and household routines (purchasing, preparation, serving, consumption, clean up).

Study findings: 79% reduction in plate waste compared with control, which averages close to 500g of waste/week or more than 20kg of waste/year. Across all sources of waste, a 46% reduction in waste compared with control.

Implications for WasteWise team:

- Personalised solutions are effective; however, they could be challenging and costly to deliver at scale
- The behavioural toolbox approach illustrates the complexity of behaviours involved in food waste. Applying this through a different delivery mechanism (e.g. online self-service quiz) may be more achievable to scale up.

Nudges to increase recycling and reduce waste (Milford et al., 2015)

Study design: Experiment with treatment groups (the ‘quantity’ treatment group received information about total household waste and the ‘recycling’ treatment group received information about recycling only) and a control group. Recycling bins fitted with RFID tags that weigh bins on collection. All groups surveyed.

Interventions trialled: Letters containing personalised information about the households recycling (weight) compared with an average of other households. One treatment group were also provided with information about the benefits of recycling and instructions.

Example letter extract below:

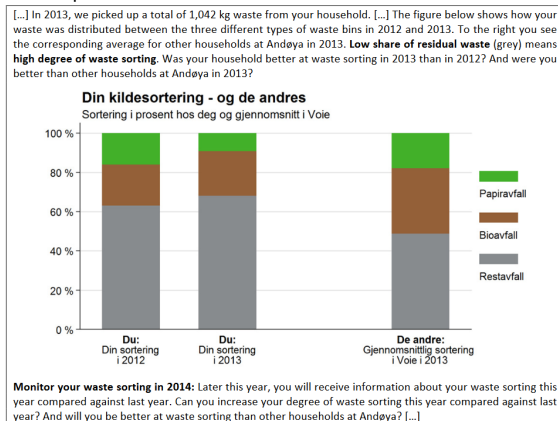


Figure 1. Extract of the first letter to the recycle group with information about degree of recycling

Study findings:

Weight of recycling increased by 3.4 percentage points for the treatment group and 0.1 percentage points for the control group. High proportions of survey respondents said the information in the letter was ‘useful’ (recycle group 71% and quantity group 73%).

Implications for WasteWise team:

- Personalised solutions that provide feedback about behaviour are effective.
- Behavioural comparisons are useful when the majority are performing the desired behaviour.

An Evaluation of Interventions for Improving Pro-Environmental Waste Behaviour in Social Housing (Woodard & Rossouw, 2021)

Study design: Engagement based approach including indicators. Observational estimates recycling bin fullness over several weeks and a follow-up survey of residents.

Interventions trialled: Sociable workshops for residents of social housing developments, cleaners and waste service providers that shared information about the impacts of waste, discussion about challenges, and demonstration of a composter. Project teams subsequently worked with residents to revise waste management at each development to deliver bespoke solutions.

Study findings:

The interventions stimulated behaviour changes, leading to increased recycling rates (+10.4% per site compared to baseline), waste reduction (0.4 kg per flat per week compared to baseline), increased recycling quality, and social cohesion.

Implications for WasteWise team:

- Bespoke engagement approaches can be labour intensive to delivery and therefore challenging to scale.
- Approach may only be applicable to housing development with communal waste facilities (e.g. apartments, social housing, terraced housing developments).

2.3 Information-free interventions

Information is a predominant component of behavioural interventions in the literature; however, interventions need not rely on the provision of information. Information-free interventions can include the use of smart appliances to provide feedback, quiz games, tools that enable behaviours (e.g. food storage containers, refuse bins), and training to improve abilities (e.g. meal planning, cooking). The evidence for some of these intervention types is lacking (as some were trialled outside of residential settings or were the subject of qualitative exploration) and would benefit from further research. A recent publication by Shift Design in partnership with WRAP⁹ contains examples of interventions that would be considered information-free. We acknowledge the lack of effectiveness evidence for many of these interventions, nevertheless this may be a useful brainstorming resource.

As with previously described interventions, these information-free examples were found to share some approaches that enabled their success, including:

- Making it fun to develop a positive association (e.g. short online quiz games)
- Making it convenient by providing the tool, not requiring tools to be acquired
- Creating a social norm by providing the tool to everyone
- Applying ‘choice architecture’ by installing the tool in a location that nudges towards the behaviour
- Providing feedback from automated data collection (e.g. motion activated fridge cameras).

The table below includes examples of interventions that employ information-free interventions. As with the previous section, evidence of their effectiveness and implications are noted. Selected case study examples containing more detail follow on.

Intervention	Evidence for effectiveness	Amount of evidence	Implications
Online quizzes and prizes	Short, timely, fun interventions such as quizzes have high engagement and resulted in a self-reported decrease in food waste (Soma et al., 2020). See case study for more details.	Medium	✓ Explore delivery of online quiz
Bin proximity	A study that provided recycling bins to households and placed this in the kitchen where most recycling waste was produced found this ‘nudge’ to be successful in	High	✓ Explore delivery of tools that assist with recycling

⁹ Available at: https://shiftdesign.org/content/uploads/2014/09/shift_Food-Waste_survey.pdf

Intervention	Evidence for effectiveness	Amount of evidence	Implications
	supporting recycling behaviour (Phillips & Sylvia Rowley, 2011).		
Home composting bin, worm farm, or bokashi system	A trial providing a home composting bin, worm farm, or bokashi system reported a significant decrease in the use of general waste as the main way to dispose of food scraps (GravitasOPG, Unknown).	Low	✓ Explore provision of home composting systems
Portion measuring tools for pasta and rice / measuring cups	Consumers who measured their pasta using the portion measuring tool (Eetmaatje) reported producing less total waste (van Dooren et al., 2020). See case study for more details.	Low	✓ Explore delivery of tools that assist with portioning food
Meal planning	Meal planning increases purchasing accuracy and reduces purchasing of surplus foods (Geffen et al., 2020; Quested et al., 2013)	Medium	✓ Explore ways to support meal planning
Fridge cameras / smart fridges	Some brands of smart fridges are available and include in-built cameras connected to a smart phone app that provide information about the fridge content. There is potential for this accessible inventory to support low-waste food management practices however, as it still requires manual checking of content it may not be convenient enough to have an impact (Hebrok & Boks, 2017). The intervention 'FridgeCam' included a camera attached to a fridge that sends images to a website of the fridge content. In testing this intervention, some participants used the images within the supermarket to plan shopping (Ganglbauer et al., 2013). See case study for more details.	Low	~ More research needed
Kitchen appliances	Kitchen appliances (e.g. blenders, toasters) can provide an opportunity to turn old, disliked or leftover food into different dishes by providing ideas (e.g. using older	Low	~ Untested intervention

Intervention	Evidence for effectiveness	Amount of evidence	Implications
	fruit in smoothies or stale bread for toasted sandwiches) (Mattila et al., 2019).		
Cooking classes	Cooking classes were reported to be effective at reducing food waste, but no evidence was provided (Reynolds et al., 2019).	Low	~ Unreliably tested intervention
Smart bins	Smart bins, such as 'BinCam', have been used to motivate reflection and evoke behavioural change (Comber & Thieme, 2013). These bins captured images of rubbish and uploaded them to Facebook where they could be explored by others. It was hypothesised that this could evoke feelings of guilt which is elsewhere evidenced to motivate food waste reduction. This was not found to be effective in changing behaviour.	Low	X Rubbish bin cameras are not recommended

Negotiating Food Waste: Using a Practice Lens to Inform Design (Ganglbauer et al., 2013)

Study design: Interviews, home tours. Two rounds of data collection, one prior to intervention installation and one a month after installation.

Interventions trialled: Fridge camera (smartphone) is installed in the door of the fridge. Camera is triggered by an accelerometer and takes a photo each time the door is opened and uploads the images to a webpage accessible to the household.



Fig. 1. FridgeCam system attached to the door (left) and picture of the inside of the fridge taken by the camera (right).

Study findings:

- Food waste is disliked (due to environmental impacts, experiences of scarcity, economic waste, social norms of clearing plates), but often perceived to be unavoidable.
- Shopping lists are generated by looking at current food stored at home. They are made when time allows for planned shopping, which not all shopping trips are. Many shopping trips are opportunistic and paired with other activities such as commuting home from work. FridgeCam assisted some participants in planning food shopping within their busy schedules in a convenient place (i.e. they did not need to be at home to plan). This ability to look in the moment removed the need to plan ahead (enabled greater flexibility) and enabled shopping trips to be opportunistic and combined with other activities. Making information about food at home available at the point of purchase could assist in making decisions that reduce food waste.
- The main purpose of a list is to act as a reminder of what to buy to avoid disappointment in forgetting an item later. Lists do not restrict 'impulse' purchases.
- FridgeCam provoked some participants to reflect on their food management behaviours as it provided evidence of their practices. Some participants prior to the installation perceived themselves to have a diet with lots of fresh produce, however, their FridgeCam told a different story. This encouraged honest reflection and acceptance that they actually eat out often and purchase frozen or tinned foods that lasts longer. Such feedback without judgement could be an approach to build awareness of personal practices as a first step towards reducing food waste. The authors suggest this feedback could assist in addressing the intention-behaviour gap.
- FridgeCam didn't have an impact for all participants. Some shopped every day for fresh food, and others had rigid practices around shopping and eating that were not influenced by the intervention.

Implications for WasteWise team:

- Creative solutions such as smart technology show potential to support reducing food waste. Further research is required.

Development and Evaluation of the Eetmaatje Measuring Cup for Rice and Pasta as an Intervention to Reduce Food Waste (van Dooren et al., 2020)

Study design: Pre- and post-intervention surveys conducted over several years. 1.6 million cups distributed for free between 2014-2019.

Interventions trialled: Eetmaatje – a portion measuring cup for rice, pasta and other grains.



FIGURE 2 | Measuring cup containing macaroni.

Study findings:

- 85-89% think the cup is handy, 50-80% report using the cup when preparing a meal, 77-87% think the cup reduces food waste.
- Actual food waste was measured separately from survey participants in 2010, 2013, 2016 and 2019 for 130 households in the same areas each time. Total food waste shows a decreasing trend: in 2010 pasta annual average waste was 2.9kg and rice 2.1kg, in 2019 rice decreased to 1.45kg and pasta at 1.35kg (however, pasta fluctuated over the years). Authors acknowledge trends of actual food waste cannot be attributed to the cup alone and are likely impacted by awareness campaigns and other related interventions.
- Factors other than food waste interpreted by authors to be primary motivators for using the cup such as convenience of cup over weighing, healthy portions, and losing weight.
- The cup is interpreted to support the development of habits, cooking skills, and act as a prompt to reduce waste.

Implications for WasteWise team:

- Tools that assist with specific barriers to reducing food waste have potential. More research is needed.

3. Application of behavioural insights

The review of waste reduction studies in the preceding section shows that while there are still gaps in knowledge, application of a range of behavioural insights have been demonstrated to encourage household waste reduction. These insights include providing timely prompts, modifying the household environment to encourage desirable behaviours, providing personalised feedback, eliciting commitments, and using descriptive norms. An extensive collection of behaviour insights appropriate for application within a local government setting is available within the Behavioural Insights Toolkit¹⁰ developed by RIMU.

There are several behaviour change frameworks/models that can be utilised to assist in identifying and overcoming barriers to behaviour in addition to applying behavioural insights to the design of interventions. In the context of limited published evidence, especially for composting and recycling, applying frameworks such as these can provide structure to the development of interventions.

One recent study provides an example of how to use both waste-specific research and a broader behavioural insights framework to provide tailored and personalised feedback to good effect (Roe et al., 2022). The research team drew on behavioural research (using the COM-B [Capability, Opportunity, Motivation, Behaviour] model described in this section below) that had identified 160 barriers and drivers for reducing food waste. They then used a ‘behavioural toolbox approach’ to tailor coaching and advice to families based on their personalised circumstances.

The Theoretical Domains Framework and Behaviour Change Wheel (an extension of the COM-B model) were applied in a study to develop recycling interventions (Gainforth et al., 2016). In this study recycling behaviours of participants were analysed using these frameworks in order to identify barriers (e.g. physical opportunities to recycle) as well as strengths (e.g. good knowledge of how to recycle), that can subsequently inform the development of interventions.

A guidebook published by the United Nations environment programme, WRAP and others, applies the Motivation, Opportunity, Ability (MOA) model to the issue of food management and food waste minimisation (Goodwin & Blondin, 2022). The MOA model is applied to different behaviours involved in food waste, such as correct food storage, and offers examples of interventions. The MOA model is very similar to the COM-B model.

Application of these frameworks is likely to benefit a range of WasteWise programmes. Two frameworks recommended for adoption by the WasteWise team are described below: The EAST framework, and the COM-B model.

¹⁰ Toolkit available at: <https://knowledgeauckland.org.nz/publications/behavioural-insights-toolkit-a-step-by-step-process-for-building-a-behavioural-intervention-with-brainstorming-cards/>

3.1 EAST framework

The EAST framework is a simple and accessible summary of behavioural principles to guide the design of behaviour change interventions. The framework highlights how if you want to encourage a behaviour, make it Easy, Attractive, Social and Timely (EAST). The EAST framework can be found at <https://www.bi.team/publications/east-four-simple-ways-to-apply-behavioural-insights/>. Its four principles are noted below:

1. Make it Easy

- **Harness the power of defaults.** We have a strong tendency to go with the default or pre-set option, since it is easy to do so. Making an option the default makes it more likely to be adopted.
- **Reduce the ‘hassle factor’ of taking up a service.** The effort required to perform an action often puts people off. Reducing the effort required can increase uptake or response rates.
- **Simplify messages.** Making the message clear often results in a significant increase in response rates to communications. In particular, it’s useful to identify how a complex goal can be broken down into simpler, easier actions.

2. Make it Attractive

- **Attract attention.** We are more likely to do something that our attention is drawn towards. Ways of doing this include the use of images, colour or personalisation.
- **Design rewards and sanctions for maximum effect.** Financial incentives are often highly effective, but alternative incentive designs – such as lotteries – also work well and often cost less.

3. Make it Social

- **Show that most people perform the desired behaviour.** Describing what most people do in a particular situation encourages others to do the same. Similarly, policy makers should be wary of inadvertently reinforcing a problematic behaviour by emphasising its high prevalence.
- **Use the power of networks.** We are embedded in a network of social relationships, and those we come into contact with shape our actions. Governments can foster networks to enable collective action, provide mutual support, and encourage behaviours to spread peer-to-peer.
- **Encourage people to make a commitment to others.** We often use commitment devices to voluntarily ‘lock ourselves’ into doing something in advance. The social nature of these commitments is often crucial.

4. Make it Timely

- **Prompt people when they are likely to be most receptive.** The same offer made at different times can have drastically different levels of success. Behaviour is generally easier to change when habits are already disrupted, such as around major life events.
- **Consider the immediate costs and benefits.** We are more influenced by costs and benefits that take effect immediately than those delivered later. Policy makers should

consider whether the immediate costs or benefits can be adjusted (even slightly), given that they are so influential. ·

- **Help people plan their response to events.** There is a substantial gap between intentions and actual behaviour. A proven solution is to prompt people to identify the barriers to action, and develop a specific plan to address them.

3.2 Capability-Opportunity-Motivation (COM-B) framework

The COM-B model (Michie et al., 2011) represents the observation that at any given moment, a particular behaviour will occur only when the person concerned has the ‘capability’ and ‘opportunity’ to engage in the behaviour and is more ‘motivated’ to enact that behaviour than other behaviours available to them. The COM-B model is a synthesis of 19 frameworks of behaviour change found in the research literature and reflects a major summary of the most powerful impacts on behaviour. Further information, including examples of its application, can be read in Michie and colleagues’ (2011) *The Behaviour Change Wheel – A Guide To Designing Interventions*.

The COM-B framework explains people’s behaviour in terms of three factors.

1. **Capability** refers to whether people have the knowledge, skills and abilities required to engage in a particular behaviour. Its two components are:

- Psychological Capability: our knowledge/psychological strength, skills or stamina
- Physical Capability: our physical strength, skill or stamina

2. **Opportunity** refers to the external factors which make the execution of a particular behaviour possible. Its two components are:

- Physical Opportunity: opportunities provided by the environment, such as time, location and resource
- Social Opportunity: opportunities as a result of social factors, such as cultural norms and social cues

3. **Motivation** refers to the internal processes which influence our decision making and behaviours. Its two components are:

- Reflective Motivation: reflective processes, such as making plans and evaluating things that have already happened
- Automatic Motivation: automatic processes, such as our desires, impulses and inhibitions

Interventions are more likely to be successful when they consider the three factors.

4. Conclusion

This literature review included a range of studies trialling interventions to reduce household waste. It found that a wide range of intervention types have been tested and many are information-based or used information as a component of an intervention package. Information only interventions (e.g. pamphlets) tend to have low effectiveness at changing behaviour. Effectiveness improves when information is paired with other interventions (e.g. prompts, modifications to the physical environment). Some interventions omitted an information component, and for many, further research is needed to assess the effectiveness of these approaches. It is recommended that the WasteWise team focuses efforts on ‘more than information’ interventions.

From the case studies emerged some generalised findings about aspects that tended to make interventions successful. Many of these findings reflect behavioural insights evidenced to work in contexts other than waste and can be applied across different types of interventions. The Ministry for the Environment has recently published a literature review of initiatives aiming to reduce household organic waste which draws similar conclusions to this literature review (Ministry for the Environment, 2022). Aspects that contribute to intervention success include:

- Use positive descriptive social norms
- Use polite language
- Provide simple information that requires no prior knowledge
- Demand audience attention through eye catching visual design
- Focus content on instructions, not explanations
- Gamification that makes it fun and social
- Make it convenient and easy
- Modify the physical environment
- Timely prompts
- Commitment devices
- Measure behaviour and provide data as personalised feedback.

The WasteWise team is encouraged to apply these generalised findings in the design of their interventions.

While the research provides some indications of which interventions are more effective, waste behaviours at the household level are complex and are influenced by a range of interacting factors. For example, the evaluation of the WasteWise programme of work that this document is designed to complement, found that many Auckland-based interventions focused on addressing other, seemingly unrelated life challenges (such as employment, financial, social) to ‘free up space’ for people to focus on their household waste behaviour. We are still limited in our understanding of the complex factors that influence waste behaviours. This is a general limitation of the behavioural science literature, which has focused so far on identifying average effects across populations. A next step in understanding is needed to identify which interventions are effective for whom, and why.

In the absence of more complete information on what is most effective, both the COM-B model and EAST framework provide direction for developing behaviourally-informed interventions to influence behaviour.

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Find out more: phone 09 301 0101, email
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