Measurement Methodologies

Methodologies to measure impact of priority interventions to reduce household food waste in Australia

FIGHT FOOD WASTE
Cooperative Research Centre
REDUCE - TRANSFORM - ENGAGE

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1. Executive summary

Over the past decade, food waste has become a globally recognised issue with the United Nations designating the Sustainable Development Goal 12.3 to halve per capita food waste by 2030. This provided an impetus for national governments around the world to devise strategies and interventions to reduce food waste across the supply chain including at the household level. Household food waste[1] in particular, makes a significant contribution to the total food waste in developed countries such as Australia. Household food waste includes all food consumed in the house (includes prepared at home, takeout eaten eaten at home and home delivered). These food could be disposed through multiple routes such as sewer or kerbside bin system, home composting, and feeding animals.

Given its significance, a good understanding of the magnitude of household food waste and effectiveness of interventions to reduce household food waste is needed. This report provides guidance on both measuring household food waste and designing interventions to reduce household food waste. Both the measuring and evaluating of household food waste interventions are challenging areas for practitioners. Although many household food waste interventions have been implemented around the globe, only a few have attempted to evaluate their effectiveness. Similarly, several measurement methodologies including surveys, kitchen diaries and waste compositional studies of household bins have been undertaken but with little understanding of how these measurement methodologies differ from each other.

The guidance offered in this report synthesises the global best practice and provides a practical overview of the topics in terms of:

- Designing an intervention including the logic mapping process (section 3);
- Survey questions to measure the impact of interventions targeting 7 priority behaviours (section 3.3)
- An in-depth discussion of three household food waste measurement tools – survey, electronic diary and bin audit methods (section 4);
- A technical analysis comparing the above three food waste measurement methods (section 5); and

[1] Various definitions of household food waste exist. In this report, food discarded through both the kerbisde bin system and all other disposal routes such as home composting, feeding to animals, organic bin routes, etc. are considered.

- A discussion of major findings from the above technical comparison (section 6).

Different household food waste measurement methods have different advantages and limitations, and accuracy levels. The comparative analysis of household food waste measurement methods revealed that survey (Mean = 2.04 kg/week/household; SD = 2.08) and electronic diary (Mean = 2.89 kg/week/household; SD = 2.74) under-estimated household food waste compared to the calculated food waste (Adjusted Mean = 3.4 kg/week/household) measurement.

The calculated food waste (3.4Kg) was arrived at by adjusting the electronic diary food waste amount (2.89 Kg which includes food disposed using all disposal routes) by a scaling factor of 1.2. This scaling factor of 1.2 reflects the underestimation between the weight of food disposed in the bin 1.5 kg based on the electronic diary and the actual bin audit weight of 1.78Kg. It was assumed that the degree of underestimation of food wasted through all disposal routes was equivalent to the degree of underestimation between the binned food waste from the electronic diary and actual bin audit weight. Table 1 summarises the scaling factors with reference to the calculated food waste value.

Table 1: Food waste scaling factors summary

	Survey	E-Diary	Bin Audit	Calculated food waste*
Disposal route: All				
Sample size	2885	1462		
Weight (Kg per household per week)	**2.04**	**2.89**		**3.4**
Scaling Factor	**1.7**	**1.2**		
Disposal route: Waste bin only				
Sample size		1462	495	
Weight (Kg per household per week)		**1.50**	**1.78**	
Scaling Factor		**1.2**		

* Calculated food waste weight adjusted to reflect the total food waste including other disposal routes (sewer, fed to animals, home composting).

According to Table 1, food waste values obtained from a self-reported survey should be adjusted by a factor of 1.7 while the same values obtained from an Electronic Diary by a factor of 1.2. These adjustment factors are for all food disposal routes. The scaling factor between Electronic Diary and Bin Audit focusing only on the general waste bin ("Red bin"/ "landfill bin") disposal route is 1.2.

Surveys (section 4.1) are more economical than the other two tools in measuring household food waste, however it under estimates food waste. The survey tool provides versality as it can gather behavioural and food waste information simultaneously. A 15-minutes survey tool implementation costs approximately $22 per participant for a representative sample size of 1400. A wide range of sample sizes have been used in food waste measurement surveys but as a general rule of thumb,

minimum of sample size of 200 participants is recommended for survey-based household food waste measurement interventions. However, the exact sample size depends on the type of intervention to be tested.

An electronic diary (section 4.2) enables the measurement of (value and weight) food waste by product (Cooked beef, banana, cooked rice etc), waste category (meat and sea food, fresh vegetables and herbs etc) and total food waste. It has the ability to capture waste as it occurs and indicate why, how and where the food was disposed. However, use of this tool required high involvement (time and effort) of both participants (to log information) and the researchers (to analyse). Further, the act of recording food waste has the potential to influence behaviour leading to lower food waste during or part of the duration of the research. High involvement of participants means there could be high attrition rates unless they are adequately compensated to fill the diary timely and accurately. The cost of implementation of a 7-day electronic diary is approximately $60 per participant.

Although the most accurate, the bin audit (section 4.3) food waste measurement is the most expensive tool costing approximately $210 per participant for a sample size of 350. An additional incentive of approximately 40-50 AUD would have to be paid to each participant if they were required to collect their waste over a week for collection by the audit team to reduce high attrition rates. Alternatively, working with the counsils to audit food waste in detail as part of a council waste audit would reduce attrition rates as it removes opt-in requirement. When considering the option of using bin audits, seasonal factors (decomposition weight loss during summer, winter vs summer fruits), special events (holidays, Christmas etc.), bin collection days etc must be considered.

The report also highlights the practical aspects that practitioners must be cognisant of when designing, implementing and evaluating the effectiveness of household food waste reduction interventions. This field of evaluation of food waste interventions is still in its infancy and, in the future, as outcomes from ongoing research efforts around the globe become available, it will be possible to streamline evaluation processes that can be applied at a local, regional or national level.

2. Introduction

Food waste costs $36.6 billion per annum to the Australian economy (FIAL, 2021). It has been estimated that households account for around 50% of the dollar value of this wasted food (Fight Food Waste Cooperative Research Centre, 2020). As such, households are a key focus when developing interventions to reduce food waste in Australia.

All household food waste reduction interventions begin with an objective for the intervention being implemented. Whether the objective or the final outcome relates to a change in households food management behaviours or total quantity food waste or both, it adds value to be able to clearly identify the change achieved by the intervention. This requires identifying the present situation and the change following the intervention. Measurement of this change will provide an indication of the effectiveness of the intervention. Using a consistent methodology will facilitate accumulation of data that will allow for comparison of effectiveness of different interventions, and for the same intervention across time.

The purpose of this report is to develop robust measurement methodologies which would be useful for practitioners to use to evaluate the effectiveness of household food waste interventions they implement in Australia. The report compares surveys, electronic diaries and bin audits as tools to gather data to evaluate the effectiveness of an intervention.

This is the seventh Work Package undertaken by the "Designing effective interventions to reduce household food waste" research project(the Household Project) within the "Engage" program at Fight Food Waste Cooperative Research Centre (FFW CRC). The seven Work Packages (WP) are:

WP1 - Australian household attitudes and behaviours national benchmarking study

WP2 - Australian household food waste behaviours, attitudes and perceived and actual food waste

WP3 - Profiles of Australian households for food waste reduction interventions

WP4 - Global best practice for designing interventions to reduce household food waste

WP5 - Priority behaviours for interventions to reduce household food waste in Australia

WP6 - Framing food waste reduction messages

WP7 - Methodologies to measure impact of priority interventions to reduce household food waste in Australia

3. Designing interventions

3.1. Objectives of intervention that could be measured and Logic Mapping

The first step of conducting an evaluation is to understand the purpose and how the intervention would lead to the final outcome. To enable this, the evaluation practitioner and the programme implementer must be in sync with the focus of the evaluation, the main questions to be answered and how each step of the intervention is conceptualised in a logic model (see Figure 1 below). Based on the theory of change[2] (Anderson, 2005). The logic model is often referred to as a Logic Map and it

[2] The Theory of change typically focuses on mapping causal relationships whilst a logic model focuses on the components of a programme implementation.

outlines how an intervention is anticipated to deliver outcomes from the intervention. It includes the basic elements of a theory of change i.e., a causal chain of inputs, activities, outputs and outcomes to be achieved. It also shows scope of the intervention. In the example below, the financial and environmental impact of the intervention is excluded (shaded boxes) from the scope. This is important not only to implement an effective technical evaluation but also to come up with clear guidelines specifying the validity and reliability of measures, and of the sample sizes required for statistical significance.

Figure 1: A logic model illustration for a food waste reduction intervention

A description of each stage depicted in the logic model (Figure 1) is provided below:

Intervention: The activity proposed to reduce food waste among households. For example, a campaign to encourage consumers to pay more attention to the use-by-date lables whilst shopping and/or to use food that are about to expire first at home.

Output: Immediate outcome(s) generated by the intervention. For example, the size of target audience reached by the check date labels campaign.

Intermediate outcomes: Intermediate outcomes include behavioural changes resulting from the intervention. For example, an increase in checking food date labels when shopping.

Final outcome: The end result of the intervention. For example, a reduction in food waste in households.

3.1.1 How to develop a Logic Map?

The development of a logic map is best carried out during the design of the intervention. Setting up team with representatives from stakeholders including sponsors of the intervention, practitioners who will be implementing intervention and consultants with expertise in behaviour change and evaluation, is useful. This will assist in forging a common vision, and to establish intervention objectives and how these will be achieved. This step will enable practitioners to build a consensus on the focus of intervention and the main questions that need to be answered.

This design team is advised to review existing literature and recent interventions to verify contexts and assumptions in the logic model. For example, the logic model illustrated in Figure 1 requires the designer team to review literature on date labelling and the experience and the impact of past interventions in this area.

3.1.2 Selecting performance indicators

Performance indicators are used to measure the impact of the intervention. It is important that the design team agrees on primary outcome indicators. For example, in the logic model presented in Figure 1, outcome indicators could be the average percentage of food waste reduced or the percentage behaviour change in checking date labels in the target population. These changes are typically referred to as Effect sizes, which indicate the expected change as a result of the food waste reduction intervention. Effect sizes are crucial to determine sample sizes needed for achieving statistically significant results from the evaluation (see section 3.4.2).

3.1.3 Changes in amount of household food waste

Changes in household food waste has been measured using several methods. Physical waste composition analyses (e.g. audit of household food waste bin) identifies food waste as a weight measure, typically for a week.

Another method is self-reporting surveys. These use various scale measures to quantify household food waste. They often use a Likert scale. This may be a 5-point scale with 1 indicating 'definitely wasting' and 5 indicating 'definitely not wasting'. A 7-point scale ranging 'not at all' to 'extremely' has been used to- measure food waste (Janssen et al. 2017). In an Italian study, Falasconi et al. (2019) measured the quantity of household food waste on a 10-point scale ranging from 'nothing' to 'a lot'. Most studies have used one week or two weeks as the reporting period.

Kitchen diary is another method of measuring changes in household food waste. An electronic diary or a manual diary could be provided to the participants who will then weigh and log their food waste for breakfast, lunch, dinner and in between meals for a minimum duration of 7 days. Having a minimum of a 7-day week is important to average out effects of any abnormalities that could occur due to an event such a fridge cleaning. Depending on the level of details required, recording could be in the form of weight of individual products, categories or total waste for the day.

Other approaches include use of photographs of discarded food (van Herpen et al., 2019), frequency of food discarded, calculated food waste proportion (the total amount of avoidable food waste divided by the total weight of food purchased), calculated monetary losses/cost (% food discarded multiplied by the total food expenses) (Elimelech et al. 2019a).

3.1.4 Changes in waste for a specific food category or a specific product

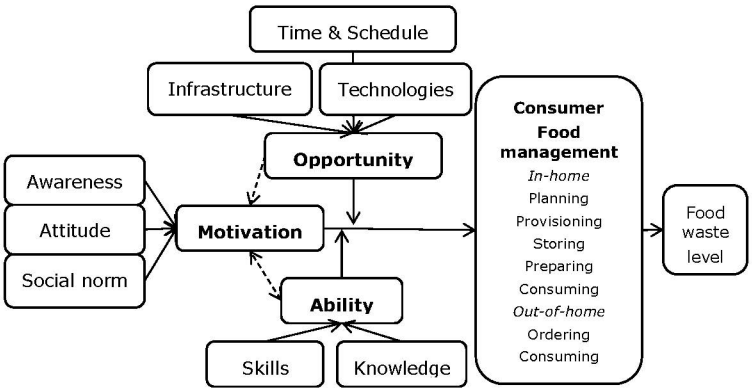
The measurement methods used for total food waste can be used to measure changes in waste for specific food categories (e.g. meat category, cooked meals or milk products). Further, some food categories are measured on a per item basis rather than weight. WRAP (2011) used a 6-point scale to measure bread waste. The scale varied from no waste to wasting 15+ slices of bread. The same study used the number of items discarded for rolls, pittas, wraps, crumpets and croissants. The frequency of food discarded for product categories has also been measured on a scale of never, sometimes, and often (Setti et al. 2016) or a 5-point scale ranging from never to most times (Young et al. 2017).

3.1.5 Changes in food planning, purchasing, storing, preparing and disposing

Practice theory advocates that the routines related to food provisioning behaviours can predict household food waste effectively (Koivupurp et al. 2012; Stefan et al. 2013, Stancu et al. (2016). These behaviours are enacted across the five components of food provisioning ie. planning, purchasing, storing, preparing and disposing. Food planning includes inventory checks, meal planning, writing grocery lists, etc. (Graham-Rowe et al. 2014; Pearson and Perera, 2018). Food shopping behaviours including the frequency of shopping, impulse buying, just-in-case buying, checking 'best before' and 'use by' date labelling (Aschemeann-Witzel et al. 2015; Stancu et al. 2916; Tucker and Farelly 2016; Evans, 2011; Canali et al., 2017). Food storage practices such as use of fridge/freezer properly, use of containers and labelling leftovers (Farr-Wharton et al. 2014) and disposal practices (Reynolds et al. 2014).

3.1.6 Changes in consumer motivation, ability, and opportunity to engage in activities supporting household food waste reduction

The Motivation, Opportunity and Ability (MOA) framework (see Figure 2) has been used to explore how indivuals respond to household food waste reduction interventions.



Source: van Geffen et al. (2016)

Figure 2: Motivation, Opportunity and Ability (MOA) framework

Soma et al. (2021) used the MOA framework to evaluate a food waste awareness campaign in Canada. The 12-week awareness campaign was based on two globally popular food waste campaigns: Love Food Hate Waste and Food Too Good to Waste (UNEP). Three types of interventions were tested in

the campaign: (1) information only; (2) community engagement and information; and (3) gamification and information.

The information only intervention included a booklet (see Figure 3), which contained information highlighting the importance of reducing food waste (motivation) and tips on reducing food waste at home (ability). It also included a series of newsletters (sent once every 3 weeks) delivered through email or postal mail and a fridge magnet, which acted as a nudge reminding the participant about the intervention (opportunity).

The community engagement and information intervention comprised a series of four learning workshops on food waste reduction at home (opportunity), activities and prizes (motivation and ability). The gamification intervention involved participants playing a weekly online trivia game (opportunity), which contained questions on impacts of food waste (motivation) and how participants can reduce food waste in day-to-day activities (ability).

A control group with no intervention was also included in the study. Focus groups (44 participants in total) were carried out after 3 months of the campaign to understand any change in participant motivation, opportunities and abilities. Participants were rewarded with a $50 grocery gift card for their attendance in the focus group.

Source: Soma et al. (2021)

Figure 3: 'Save Food, Save Money, Save the Planet' awareness campaign in Canada.

The focus group involved 3-9 semi-structured questions customised for each intervention to guide the discussion. Participants were asked about the usefulness of information (information intervention group), whether they have implemented any of the tips provided (all 3 intervention groups), if not why, whether the 'programme changed the amount of food wasted in your household and how?'. The authors used the Ryan and Bernard (2003) approach to identify thematic categories emerging from the focus groups. The study concludes that MOA framework is effective in identifying the strengths and weaknesses of interventions trialled. However, it neither measured nor commented on the final outcome – the change in food waste at home because the main focus was to identify the strengths and weaknesses of interventions.

3.2. Types of interventions

Behavioural change literature identifies a wide-ranging classification framework to organise various intervention types (Stöckli et al. 2018). Two broad categories of interventions have been identified based on the stage that intervention affects target behaviour. Antecedent interventions aim to change

the context that precedes the target behaviour while consequence interventions aim to alter the consequences of target behaviour (Stöckli et al. 2018). The table 2 provides examples of each type of intervention.

Table 2: Classification of interventions

Antecedent	Consequence
Informational interventions	Feedback
Prompts/Nudges	Rewards
Modelling	Penalties
Commitment/Goal setting	-

Source: Stöckli et al. (2018)

Another classification delineates food waste reduction interventions into two categories: Applied interventions versus initiatives aiming to understand how change occurs within the intervention process (Reynolds et al. 2019).

Applied intervention: These interventions aim to reduce food waste across a given population or sub-population.

Initiatives to understand the process of intervention: These aim to understand and evaluate how an applied intervention works.

Another classification of interventions considers the benefits and barrries.

Table 3: Schultz's behaviour-change intervention typology

		Benefits	
		Low	High
Barriers	High	Incentives, Contests	Commitments, Make it Easy
	Low	Social Modelling, Social Norms	Cognitive Dissonance, Education, Feedback, Prompts

Source: Schultz (2014)

Each of the interventions listed in Table 3 are discussed below.

Incentives: Incentives are reward strategies aimed at changing behaviour. For example, a financial incentive to enhance the purchase decision of smaller-packaged food items that cause less wastage or offers direct financial incentives to purchase devices or equipment (e.g. smart fridges[3]) that reduce food waste at home.

Contests: Competitions between individuals or groups (e.g. school groups), games that enable individuals or groups to win prizes for achieving certain levels of food waste reduction can be effective tools of behaviour change.

Commitments: This is a verbal or written agreement to conform to desired behaviour by signing a pledge (or promise cards). A public pledge compels and encourages the participant to adhere to the commitment.

Make it Easy: Providing 'supportive infrastructure' to reduce food waste (e.g. smart fridges or apps)

Social Modelling: This involves demonstrating the desired behaviour. Modelling is considered as a relatively effective intervention type (Osbaldiston and Schott, 2012).

Social Norms: Activation and manipulation of social norms are widely used in food waste reduction interventions. These involve emphasising what most people are doing.

Cognitive Dissonance: Cognitive dissonance is the state of psychological discomfort when a person's actions are incongruent with his or her values. Dissonance-based food waste interventions focus on the gap that exists between an individuals' normative beliefs and their actions to invoke behaviour change (Pelt et al., 2020).

Education: Information-based campaigns are the most widely used food waste interventions. They involve either educating and/or raising awareness about food waste in the general public or target populations.

[3] Intelligent fridge concept includes FridgeCams, expiration date alert and an ability to print a grocery list and send to the uses via text or email messages (Hebrok and Boks, 2017). Intelligent fridges, for example, can measure internal environmental conditions of a fridge and regulate it to optimise storage conditions, manage supply activities and shopping lists, detect and monitor food packages and their content, alert retailers and consumers about expiration dates and suggest recipes to consumers with the food products or packges stored in the fridge (Vanderroost et al. 2017).

Feedback: The use of social comparison of behaviour (e.g. used to reduce energy consumption and the towel usage in hotels).

Prompts: Visual or auditory messages that intend to prompt or nudge people to perform a desired behaviour (Stöckli et al., 2018). Nudges are useful in activating social norms relating to food waste (see Figure 4 for example of encouraging the diners to use doggy bags for meal leftovers in restaurants).

Source: Giaccherini et al. (2021)

Figure 4: Food waste nudging experiment in a restaurant setting in Italy.

3.3. Measuring the impact of priority behaviours

Previous work has identified priority behaviours for interventions to reduce household food waste in Australia (Ananda, Karunasena, & Pearson, 2021). This was achieved by identifying behaviours that are linked with high or low food waste as well as identifying the most wasted food products and behaviours linked with these wasted products. This report recommended prioritisation on interventions focussing of the following behaviours, listed according the to the ones likely to have the biggest impact on reducing household food waste for Australia.

1. Prepare the right amount of food
2. Keep some flexibility when planning meals
3. Eat leftover food
4. Purchase the right amount of food
5. Use the oldest food items first
6. Store food correctly in the fridge and freezer

7. Start with smaller servings of food

The following sections present questions that are specific to measuring the impact of interventions that aim to shift these behaivours.

3.3.1. Measuring interventions focused on encouraging the behaviour "prepare right amount of food"

Table 4:Measuring interventions focused on encouraging the behaviour "prepare right amount of food"

	ROTATE STATEMENTS	Almost every time (over 90%)	Most times (about 75%)	Half the time (about 50%)	Sometimes (about 25%)	Rarely / Never (less than 10%)	Don't Know/Not applicable
A	**I aim not to** have any leftovers	◯5	◯4	◯3	◯2	◯1	◯99
B	Before cooking, I think carefully about the **quantities needed** to prepare the meal	◯5	◯4	◯3	◯2	◯1	◯99
C	**I measure** the **ingredients** necessary for the meal	◯5	◯4	◯3	◯2	◯1	◯99
D	I prepare **extra food just in case** it is needed	◯5	◯4	◯3	◯2	◯1	◯99
E	I find it **difficult to deviate from a recipe** (ingredients and quantities)	◯5	◯4	◯3	◯2	◯1	◯99
F	When preparing a meal, I find it difficult to estimate **how much**	◯5	◯4	◯3	◯2	◯1	◯99

	food my **household** will **eat**						

3.3.2. Measuring interventions focused on encouraging the behaviour "keep some flexibility when planning meals"

Table 5: Measuring interventions focused on encouraging the behaviour "keep some flexibility when planning meals"

	ROTATE STATEMENTS	Almost every time (over 90%)	Most times (about 75%)	Half the time (about 50%)	Sometimes (about 25%)	Rarely / Never (less that 10%)	Don't know / Not applicable
A	My meal **plan** includes space for **eating out or meal delivery** (i.e. in a 5 day week, make meals plans for only 3 to 4 days)	◯5	◯4	◯3	◯2	◯1	◯99
B	When I **plan** for our meals, I include an **"eat leftovers"** day	◯5	◯4	◯3	◯2	◯1	◯99
C	I don't **cook the meals** I planned	◯5	◯4	◯3	◯2	◯1	◯99
D	I have to deal with **last minute changes** of plans (family members don't turn up for meal etc.)	◯5	◯4	◯3	◯2	◯1	◯99

3.3.3. Measuring interventions focused on encouraging the behaviour 'eat leftover food'

Table 6: Measuring interventions focused on encouraging the behaviour 'eat leftover food'

		Almost every time (over 90%)	Most times (about 75%)	Half the time (about 50%)	Sometimes (about 25%)	Rarely / Never (less than 10%)	Don't Know/Not applicable
A	Prepare food which is not eaten, and **dispose of** these leftovers **straight away**	◯5	◯4	◯3	◯2	◯1	◯99
B	Prepare food which is not eaten, store these leftovers, and **end up eating them**	◯5	◯4	◯3	◯2	◯1	◯99
C	Prepare food, which is not eaten, store these leftovers, and end up **disposing of them**	◯5	◯4	◯3	◯2	◯1	◯99
D	Use leftovers to **create new dishes**	◯5	◯4	◯3	◯2	◯1	◯99
E	I don't know how to use **cooked leftovers**	◯5	◯4	◯3	◯2	◯1	◯99
F	I don't know how to use leftover **uncooked ingredients**	◯5	◯4	◯3	◯2	◯1	◯99

G	I don't know how **to store food** correctly to extend its life	◯5	◯4	◯3	◯2	◯1	◯99
H	I find it difficult to estimate if food is **still safe to eat** based on seeing, smelling, and / or tasting	◯5	◯4	◯3	◯2	◯1	◯99

3.3.4. Measuring interventions focused on encouraging the behaviour "purchase right amount of food"

Table 7: Measuring interventions focused on encouraging the behaviour "purchase right amount of food"

	ROTATE STATEMENTS	Almost every time (over 90%)	Most times (about 75%)	Half the time (about 50%)	Sometimes (about 25%)	Rarely / Never (less than 10%)	Don't Know/Not applicable
A	I **Plan** the meals to be cooked	◯5	◯4	◯3	◯2	◯1	◯99
B	I Plan for the **quantities of ingredients** needed to prepare meals I planned	◯5	◯4	◯3	◯2	◯1	◯99
C	I write a complete shopping **list** of **everything** needed	◯5	◯4	◯3	◯2	◯1	◯99
D	I only buy what is on the shopping **list**	◯5	◯4	◯3	◯2	◯1	◯99

E	I buy food for '**just in case**'	◯5	◯4	◯3	◯2	◯1	◯99
F	I find it difficult to estimate how **much food I need to buy**	◯5	◯4	◯3	◯2	◯1	◯99

3.3.5. Measuring interventions focused on encouraging the behaviour "use the oldest food items first"

Table 8: Measuring interventions focused on encouraging the behaviour "use the oldest food items first"

	ROTATE STATEMENTS	Almost every time (over 90%)	Most times (about 75%)	Half the time (about 50%)	Sometimes (about 25%)	Rarely / Never (less than 10%)	Don't Know/Not applicable
A	I try to use up the **oldest** food first	◯5	◯4	◯3	◯2	◯1	◯99
B	I'm not sure what '**best before' and 'use by'** dates mean	◯5	◯4	◯3	◯2	◯1	◯99

3.3.6. Measuring interventions focused on encouraging the behaviour "store food correctly in the fridge and freezer"

Table 9: Measuring interventions focused on encouraging the behaviour "store food correctly in the fridge and freezer"

	ROTATE STATEMENTS	Almost every time (over 90%)	Most times (about 75%)	Half the time (about 50%)	Sometimes (about 25%)	Rarely / Never (less that 10%)	Don't know / Not applicable
A	I read the **instructions** provided on packages before storing	◯5	◯4	◯3	◯2	◯1	◯99
C	I move the oldest food items to the **front or top** so that they can be used first	◯5	◯4	◯3	◯2	◯1	◯99
D	I use storage **containers** to keep food for as long as possible	◯5	◯4	◯3	◯2	◯1	◯99
E	I put food in the **refrigerator/ freezer** so it keeps for as long as possible	◯5	◯4	◯3	◯2	◯1	◯99
F	I keep the **temperature** in the **fridge** below 4° C and **freezer** below -18° C	◯5	◯4	◯3	◯2	◯1	◯99
G	I find it hard to fit food into the fridge and/or freezer because it's **already full**	◯5	◯4	◯3	◯2	◯1	◯99
H	I don't know how **to store food** correctly to extend its life	◯5	◯4	◯3	◯2	◯1	◯99

3.3.7. Measuring interventions focused on encouraging the behaviour "start with smaller servings of food"

Table 10: Measuring interventions focused on encouraging the behaviour "start with smaller servings of food"

	ROTATE STATEMENTS	Almost every time (over 90%)	Most times (about 75%)	Half the time (about 50%)	Sometimes (about 25%)	Rarely / Never (less that 10%)	Don't know / Not applicable
A	I let **others serve** themselves	◯5	◯4	◯3	◯2	◯1	◯99
B	I encourage serving **small quantities** with option for second servings	◯5	◯4	◯3	◯2	◯1	◯99
C	I experience household members **not finishing their meals**	◯5	◯4	◯3	◯2	◯1	◯99

3.4. The evaluation approach

Food waste reduction interventions can be evaluated for their process efficacy as well as their outcome efficacy. This section focuses on the latter - measuring the effectiveness of food waste reduction outcomes. This is a challenging task since there are many factors outside the intervention influencing household food waste changes. A robust evaluation must be able to tease out the effect that the intervention had on household food waste from all other confounding factors. This section discusses the intervention design elements that must be considered by practitioners at the planning stage of the intervention.

3.4.1. Experimental design

Most intervention evaluation studies comprise of pre- and post-test design. A pre-intervention or pre-experimental measurement of food waste and associated behaviour is necessary to establish the baseline situation. This is usually followed by an experimental phase in which the intervention is introduced to the target group or the 'treatment group'.

In the ideal situation there would also be a 'control group' who are not exposed to the intervention experienced by the 'treatment group' (Discussed further in section 3.5 following). The treatment group and control group should be divided in order to avoid potential spill-over or contamination. For example, if an awareness campaign was implemented within a local government area, thus becoming the treatment group, then control group should come from another local government area.

Single intervention versus multiple intervention is a common dilemma when designing food waste intervention projects. Often, multiple interventions are implemented (Reisch et al., 2021) and the effects of interventions can be confounded together. This confounding of multiple interventions can make it difficult to verify the impact of an individual interventions (Osbaldiston and Schott, 2012). For example, the experimental group might have received both a reward for reusing leftover food and feedback about how much they have reused whereas the control group received neither of these things. There is no way to separate the effects reward intervention versus the feedback intervention. Single interventions provide a better evidence base for evaluating impact (Reisch et al. 2021).

3.4.2. Effectiveness of interventions

Scientific studies that quantitatively analyse the effectiveness of household food waste interventions are scarce (Stockli et al. 2018). Some evidence can be found from the broader environmental behaviour literature on the effectiveness of interventions on behaviour change. It is contended that environmental and informational messaging (interventions) are less effective than the ones targeting social norms to alter behaviour (Osbaldiston and Schott, 2011) which are inherently more stable and hence more resistant to change. Social norms are a set of beliefs about the behaviour of others (Schultz, 1999). However, changing social norms is still possible and usefu. For example, in a field experiment focusing on curbside food waste behaviour, Geislar (2017) found that communicating social norms of waste separation helped to alter behaviour. In a meta-analysis of studies that evaluated interventions promoting pro-environmental behaviour, the effect sizes ranged from high to low as follows: cognitive dissonance (g = 0.93), goal setting (g=0.69), social modelling (g = 0.63), prompts (g = 0.62), make it easy (g = 0.49), rewards (g = 0.46), justification (g = 0.43), commitment (g = 0.40), feedback (g = 0.31) and instructions (g = 0.31) (Osbaldiston and Schott, 2012).

3.4.3. Longitudinal Field Experiments

Many studies have report associations between amount of food waste and specific behaivours in the household. However, experimental approaches are needed to establish causality in food waste interventions. In particular, field experiments, as opposed to laboratory experiments, conducted over

time would satisfy the requirements of a robust evaluation (Romani, Grappi et al. 2018). Such methods belong to the category of longitudinal field experiments. These studies can be expensive and time-consuming.

Informational intervention used in a longitudinal field experiment

THE WEEKLY MENU

Why it's worth giving it a thought, and perhaps more than one

Very often in Italian families those responsible for preparing meals, as the hour of lunch or dinner approaches, open the fridge and ask themselves: what do we eat today? The products are there, but the ideas are frequently not, and that weekly menu we so often avoid making would really come in handy. Planning meals for the week can in fact be invaluable in resolving the problem of feeding the family.

The weekly menu, needless to say, possesses a long list of advantages:

1. It prevents the wasting of money and food: it helps you avoid buying food that is unnecessary and will never be used.
2. It saves shopping time: if you plan for the week ahead it is easier to draw up a complete shopping list, thereby avoiding those last-minute trips to the supermarket because something is missing.
3. It shortens planning time: it allows you to concentrate just once on fixing the weekly menu instead of worrying daily over 'what now can I put on the table?' Not to mention the fact that, with the passing of time, you can avoid making new menus simply by using those that have already been devised and have turned out the best.
4. It compels you to have an overall view of the week and so guarantees your family a healthier, more balanced menu, for example by cutting out convenience foods.
5. It reduces considerably the degree of stress connected with food: you don't have to think every day about what to prepare for lunch and dinner.
6. It increases consensus among the family members about what to eat: what is usually appreciated is a greater alternation of the dishes arriving on the table.
7. It saves you time in preparing food and paying bills: looking at the week as a whole makes it much easier to amalgamate burdensome operations in terms of time (such as cleaning vegetables for dinner and for the next day's lunch) or energy expenditure (for instance using the oven to cook a main course and at the same time the breakfasts and snacks of the following days).

Where to begin?

The first step is undoubtedly to provide a support system on which you can set out your own weekly menu. Whether you are still paper-bound or technological converts, here are some tips that will help you save time and energy.

You can save on your PC, in Excel format, the quick and easy model we have prepared for you for your weekly menu (available upon request from the authors).

The model you will find in front of you is composed of two worksheets:

a) A weekly plan with a grid already preset for printing in A4 horizontal format;

b) Dish list: a variety of useful lists for drawing up the weekly menu.

In the lists of the second worksheet you can insert dishes that could represent ideas for breakfast, snack, lunch, afternoon snack, and dinner. Don't leave anything out, no idea is banal. Update and extend these lists whenever you need to.

Now turn to the worksheet for planning the weekly meals and select, by clicking the cursor beside each blank cell, the chosen dish. Leave a blank space for improvisation in calmer weeks and type in the dishes for special occasions. Print it and keep it on the fridge – it will remind you what to take out when you open the fridge for the usual meal preparation.

Further suggestions to help prepare the weekly menu.

Start off by making a list of whatever dishes you can cook that come to mind. Think simple, and think of recipes you're able to carry out. Forget about cookery books and web sites: indeed, forget about everything that is too elaborate and complicated to make.

Involve the rest of the family, but collect only those preferences that you know you can satisfy or hand over completely to the person who suggested it.

In the drawing up and subsequent realisation of the weekly menu, also consider the possibility of employing anticipation strategy. The vegetables to be eaten raw can be washed, dried and kept in closed bowls in the fridge, ready to be dressed and served. The same can be done with cooked vegetables; it is possible to prepare in advance sauces to be used in pasta dishes. For a special breakfast one can make an easy cake which, kept covered, will remain fresh even for 4-5 days.

Finally, when drawing up the weekly menu always bear in mind that you can have allies. Do you go for dinner to relatives or friends and do they offer you the leftovers? Accept and smile, these are ready meals. Still keep the freezer filled for the weekly emergencies. For a few euros you can get suitable tubs, cook and freeze – already in portions – sauces, meat or fish main courses, cooked vegetables, flans, savory tarts, creamy soups. In this way, you will always have a supply of healthy food to defrost when needed.

Source: Romani et al. (2018)

Figure 5: Intervention focusing on planning for food preparation

3.5. Causal inference and counterfactuals

Causal effects are challenging to ascertain. In food waste interventions, the core research question is, 'did the intervention reduce food waste in the target population?'. The cohort that is targeted by the intervention is referred to as the 'treatment group'. Simply observing that a reduction in food waste (the outcome) in the target population is not sufficient to establish causality. The target cohort may have reduced food waste because of their own efforts, some shift in the external context like changing food prices, rather than as a result of the intervention. A robust evaluation must rule out the possibility of factors other than the intervention explaining the observed reduction in food waste. The fundamental impact evaluation formula can be conceptualised as follows:

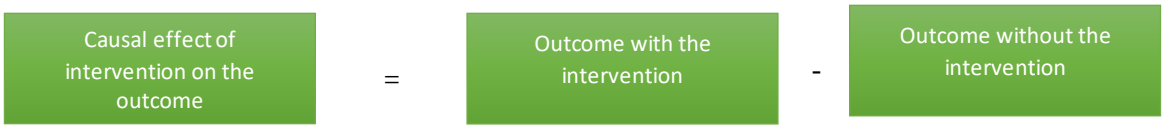


Figure 6: Fundamental impact evaluation formula

A counterfactual is defined as the outcome in the absence of the intervention. i.e. what would have happened to food waste in households if they did not participate in the intervention. However, one cannot directly observe the counterfactual because the participant either took part or do not take part in the intervention. Therefore, the counterfactual must be estimated using a 'control group', which is identical to the treatment group. In practice, it is challenging to identify a control group that is statistically identical to the treatment group. There are a key aspects that must be similar in both groups:

1. On average the characteristics of both groups must be the same.
2. The intervention (say an informational campaign) should not affect the control group either directly or indirectly.
3. If the intervention is given to both groups the outcome should be the same.

Treatment and Control Groups in a food waste intervention

Schmidt (2016) tested a food waste prevention intervention by dividing a baseline sample of households into an experimental group (the treatment group) (n = 108) and a control group (n = 109) using a randomisation technique. The experimental group was given a set of behavioural recommendation to prevent food waste together with a public commitment and goal setting tasks, but the control group did not receive this information. The outcome variable was the 'self-reported performance' of recorded food waste preventing behaviour. The outcome variable was measured in the experimental group approximately four weeks after the implementation of the intervention. Randomisation checks were carried out in both experimental and control groups by statistically comparing (t-tests) socio-demographic differences to ensure a valid control group and therefore the evaluation measures the impact accurately.

3.6. Sample size calculations

Selecting a sample is a crucial step in evaluating an intervention. When sample size is small, the evaluation can only detect statistically significant changes when there is a large change (or large effect). Key guiding principles of sample selection are: (a) identify the 'population of interest'; (b) determine the 'sampling frame'; and (c) draw as many observations from the sampling frame as specified by 'power calculations'. The population of interest can be defined by the sector in which outcomes will be measured (e.g. households), socio-demographic profile (e.g. consumers aged 18-24 years), and the geographical coverage (e.g. local government area, state, or national).

A sampling frame is the most comprehensive list of characteristics of the population of interest. It should be sufficient to ensure that inferences made from the sample can be generalised to the population in question.

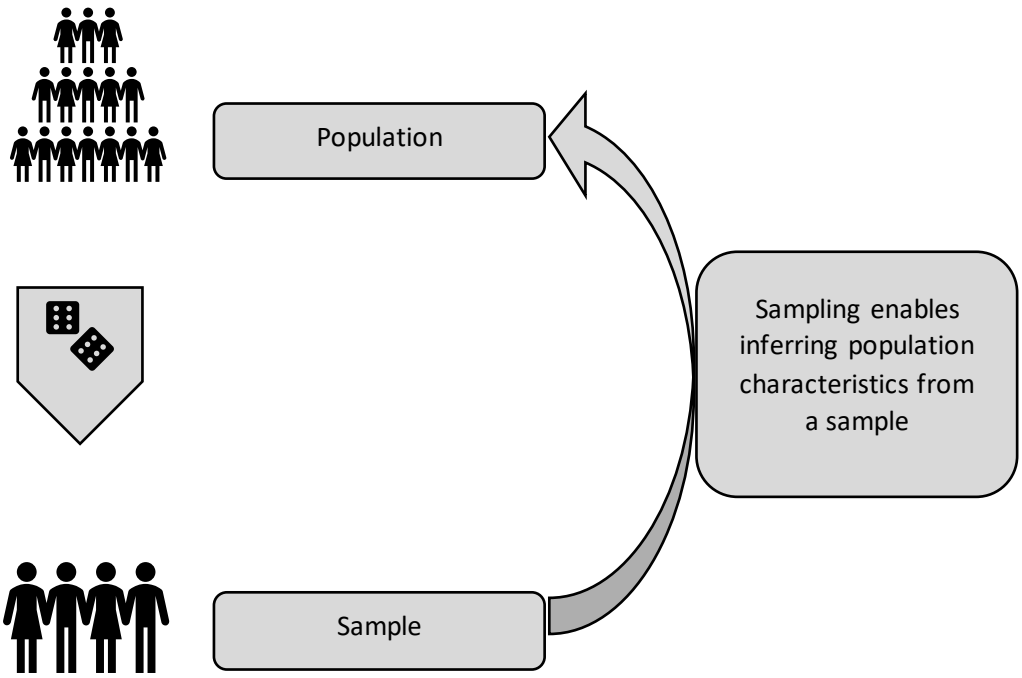


Figure 7: Sampling enables the evaluation to infer outcomes for the population

3.6.1. Sampling techniques

Probabilistic sampling is the most rigorous sampling approach and there are three main types of probabilistic sampling methods: Random sampling, Stratified random sampling and Cluster sampling. Random sampling ensures that every observation (e.g. every household in a region is the sampling

frame) has an equal probability of selection. With stratified random sampling, the population is divided into groups (e.g. based on household income or age of the person responsible for food management at home). This ensures that each observation in each group has the same probability of selection for the sample drawn. Where as with cluster sampling involves grouping observations into clusters and then drawing a random sample from these clusters. In this case, each cluster has an equal probability of being selected for the sample drawn.

Strength in Numbers

Imagine a household food waste reduction campaign target 1000 randomly selected households as the treatment group and another 1000 randomly selected households as the control group. Assume that average food waste reduction in participating households (the treatment group) is 750g per week and the average for the non-participating group (the control group) is 600g per week. The difference between the two groups is 150g. If the whole assessment is based on a sample of ten households each, you would not be very confident about the estimate because the entire or large portion of the 150g difference could be due to a measurement error.

The goal of the evaluation is to test the hypothesis that the intervention has made a difference. Often, this can be operationalised as: Is the average food waste in the treatment group after the intervention different to that in the control group? In statistical language one can formulate a Null Hypothesis that there is no difference in the average food waste between the treatment group and the control group. An effective food waste reduction intervention should be able to reject the Null Hypothesis and thus conclude the intervention was effective as there was a statistically significant reduction in the average food waste in the treatment group when compared to the control group.

From the statistical perspective there are two types of errors that can be made in intervention evaluations. On the one hand, the evaluator is concluding that the intervention had an impact when in reality, it had no impact. This is called Type 1 error by statisticians. On the other hand, the evaluator can conclude that the intervention had no impact, when in fact it has had an impact. This type of error is referred to as a Type II error by statisticians. The former can be minimised by setting a higher significance level, say 5% or 1%. At 5% significant level, the evaluator is 95% confident and at 1% level, the evaluator is 99% confident in concluding that the intervention has had an impact. However, Type

II errors are hard to deal with, but thoughtful selection of the sample size helps to minimise this error. How to manage this will be discussed in the following section.

3.6.2. Power calculations

In situations where results from evaluation of a food waste intervention show there is no difference in average food waste in both treatment and control groups leads to a question. This question is whether the average is similar because the intervention had no effect or because data is not sufficient to identify the effect. Statistical power or power[4] of an impact evaluation is the probability that it will detect a difference between the treatment group and control group, when there is a difference.

There are several steps involved in power calculations:

1. Determine the most important outcome indicator (e.g. the quantity of food waste reduced per week). This should emanate from the Intervention objectives, theory of change and specified outcome(s).

2. Determine the minimum impact anticipated from the intervention. For example, is 5% reduction in household food waste worthwhile for the intervention to go ahead? Put differently, what is the percentage of food waste reduction, below which the intervention is deemed unsuccessful? Answers to these questions yield the minimum detectable effect anticipated from the implementation of intervention. It should be noted that it is easier to identify a large difference between groups compared to a small difference. To detect smaller impact (effects) requires a larger sample.

3. Ascertain basic parameters of outcome indicators such as the average food waste reduction from an intervention. Benchmark studies and available literature could provide a baseline to start with. For example, an intervention can potentially reduce a product waste by 40g per week per household and assume this translates to a standardised effect size of 0.10 (see below for a description of effect size). This implies that the mean difference is equivalent to 0.10 in units of the population standard deviation of product waste. Effect sizes can be heterogenous and some interventions can produce larger changes in behaviour or large effects compared to other interventions.

[4] Statistical power = 1-β, where β is the probability of a Type II error (false negative).

4. The evaluator or the evaluation team must agree on an appropriate power level and significance level for the planned intervention. The power level ranges from 0 to 1 with high values indicating less risk of failing to detect an impact. A power of 0.8 is a widely used benchmark for power calculations. The significance level is often set at 5%. The smaller the significance level, the more confident the evaluator can be that the impact is real.

There are open source statistical software and websites (e.g. G*Power; Optimal Design; SurveyMonkey; ABS) that can calculate the required sample size once the evaluator has answers to the above questions.

Determining sample size

Assume that you want to calculate the survey sample size required to test the effectiveness of a product waste reduction intervention. The available literature suggests a 0.10 standardised effect size for the intervention and you are comfortable with 0.80 statistical power and 5% significance level. The optimal sample size using above parameters is 782. The below diagram illustrates the approximate sample size according to the statistical power used (see Figure below).

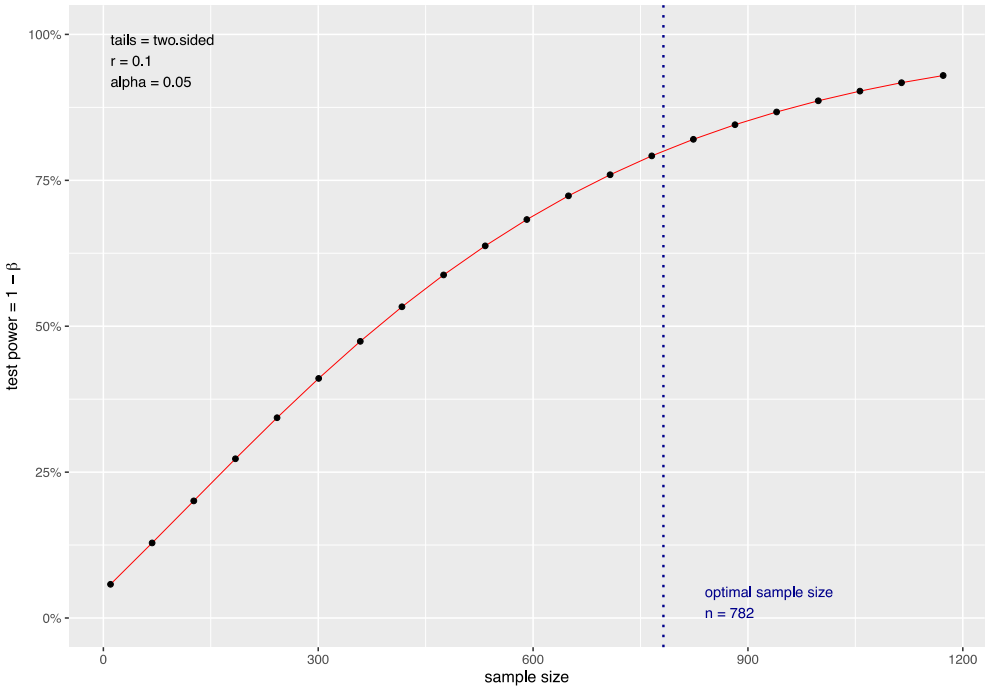


Figure 8: Sample size for a small effect

In Figure 8 a worked example is provided. with the vertical dotted line where with a

To achieve a statistical power (or test power) of 80% (vertical axis), standardised effect size r = 0.1 and a 5% significance level, the minimum sample size is equal to 782 (n = 782).

Note that the above calculation does not take into account the response rate of the survey. For example, if the response rate for a similar survey is 30%, then 2607 participants should be invited in the first place to obtain the desired sample size for hypothesis testing.

Sample size and statistical power

Some studies have reversed the process by verifying the appropriateness of the sample size by using the power analysis. For instance, in a study examining the differences in food waste generation by various household types (e.g. Apartments, Villas and Family Houses) in South Korea, Adelodun et al. (2021) used the power analysis to determine the influence of specific sample size on food waste data distribution. A sample size of 84 deemed adequate to detect a difference of food waste (2.47 kg) using 0.90 power and 95% confidence interval.

Effect size quantifies the relationship between two entities capturing the direction and magnitude of the relationship. Typically, the statistical significance is denoted by *p*-values whereas practical significance is depicted by effect sizes. One can find a high statistical significance but if the effect size is small, it has minimal practical significance. If the effect sizes of various food waste behavioural interventions are available, practitioners can easily make judgements about which intervention type they should be selecting to achieve a reduction of food wastage. For an intervention evaluation, the effect size can be conceptualised as the difference in the mean of outcome variable of the intervention group (treatment group) and the control group. Standardised effect size (Cohen's *d*) is calculated by dividing the mean difference by standard deviation of the pooled data (both groups):

$$d = \frac{\overline{x_1} - \overline{x_2}}{s}$$

Where *d* is the effect size, $\overline{x_1}$ is the mean of Group 1 (Intervention or treatment group) and $\overline{x_2}$ is the mean of Group 2 (control group) and *s* is the pooled standard deviation based on data from both groups.

An example of evaluation an intervention is provided by Young et al. (2017) who reported a field experiment[5] carried out to evaluate the use of social media (Facebook 'leftover food' campaign) by a UK supermarket, ASDA, to induce behaviour change among customers (*n* = 2018). In the intervention, ASDA customers posted their favourite recipes using leftover food on ASDA's Facebook page, which directed participants to a website providing 'Love Food Hate Waste' tips from WRAP on reducing food waste at home. Food waste of participants was measured in three-time intervals using both frequency and quantity (self-reported). Repeated ANOVA results produced an effect size[6] of 0.01, which was quite small but statistically significant.

3.4.3 Sample sizes with food waste diary studies

A range of sample sizes has been used to conduct food waste diary studies (see Table 11). They range from a few households to hundreds of households. For example, Withanage et al. (2021) reported that the sample size varied from 20 households to 385 households in the five studies that have used food waste diaries for food waste measurement. Most of these studies have been conducted over a week period, one study that had a duration of two weeks, and another reported weekly food waste over 8 months (Withanage et al., 2021).

Table 11: Sample sizes in food waste diary studies

Study	Sample size	Country	Remarks
WRAP (2013)	993	UK	Paper-based food diary
Giordano et al. (2019)	385	Italy	Shopping habits (discount purchasing) and food waste quantities
WRAP (2009)	284	UK	Paper-based food diary
Ammann et al. (2021)	223	Switzerland	A comparison of survey and food waste diary
NRDC (2017)	120	USA	A comparison of food waste diary and WCA
van Herpen et al. (2019)	48	The Netherlands	A multiple food waste measurement comparison
Williams et al. (2020)	37	Sweden	Food packaging and food waste

[5] See Grainger and Stewart (2017) for a critique of this study.
[6] The effect size quoted here is the multivariate partial eta squared.

Richter and Bokelmann (2017)	25	Germany	Food provisioning behaviours and food waste
Roe et al. (2020)	24	USA	Incorporating FoodImage™ smartphone app
Verghese et al. (2014)	23	Australia	Incorporating photographs and stored food that has gone off

It appears there are only a handful of studies have used large samples (greater than 200 participants) to measure household food waste with food waste diaries, no doubt in a large part due to the relatively high cost on a per respondent basis. The suitability of food waste diaries to track food waste changes over time has been questioned (Quested et al., 2020), however technological improvements (such as using scales to measure food, and an 'electronic diary' to record the food) have the potential to enhance its accuracy.

3.4.4 Sample sizes of survey-based food waste studies

Survey-based food waste estimations have been widely used with large sample sizes (greater than 200 respondents). Other than a few exceptions (e.g. Visschers et al. (2016)), almost all survey-based food waste studies have been conducted using online surveys.

Table 12: Sample sizes in survey-based food waste studies

Study	Sample size	Country	Remarks
Aschemann-Witzel et al. (2021)	4214	Denmark, Germany, Norway, Sweden, the Netherlands	Five country study of life-style patterns influencing food waste
Young et al. (2017)	2018	UK	Social media and food waste across seven food categories
Stancu et al. (2016)	1062	Denmark	Food waste measured as a percentage of food purchased

Jörissen et al. (2015)	857	Italy and Germany	Food waste behaviours of employees of two research centers
Aschemann-Witzel et al. (2017)	848	Denmark	Sub-optimal foods and food waste
Visschers et al. (2016)	796	Switzerland	Paper-based survey to quantify food waste across 11 categories
Bogevska et al. (2021)	754	Macedonia	Food waste perceptions and food waste
Janssen et al. (2017)	506	The Netherlands	Food waste index focusing fresh, frozen and ambient food products
Ponis et al. (2017)	500	Greece	Food provisioning behaviours and food waste
Graham-Rowe et al. (2015)	204	UK	Behaviours associated with fruits and vegetable waste

4. Research tools for measuring impact of household food waste reduction interventions

To evaluate the impact from an intervention it is necessary to identify characteristics of a representative sample from the target population for the intervention. Qualifying or screening criteria will be based on having been at home most of the period being investigated (such as preceding week), having a substantial role in responsibility for food provisioning (such as mainly or jointly responsible for at least 3 of the 5 food management activities) and having a normal week (no parties or special events that can lead to abnormal amounts of food being disposed). In addition, quotas will be required for various demographic characteristics (such as age groups, gender, number of people in household, whether children are part of household). If the strategy for an intervention requires volunteers, screening and quota restrictions are not possible. However, it is still important to collect this information so the evaluation team is able to understand characteristics of those who have participated.

The following sections discuss the use of three most commonly used instruments to measuring impact of household food waste reduction interventions. These evaluation tools are a survey, diary or bin audit.

4.1. Survey

4.1.1. How to use a survey

Surveys are the most commonly used tool for gathering data on the changes in food management behaviours and the quantity of food waste in households. This is because they are low cost on a per respondent basis and relatively easy to administer for gathering data. However, prior studies show that quantity of food waste identified using a survey, which is self-reported by the respondent, is considerably lower than the actual value. As such, this under-reporting with surveys must be remembered when interpreting food waste amounts as determined from a survey. Section 6 of this report provides more details on the degree of under estimation and suggests an adjustment factor to be used when interpreting findings from a survey.

4.1.2. Cost per head

The following quote is for a 15-minute survey for a sample that is representative of the Australian population.

	Total cost (AUD)*	Cost per head (AUD)*
Sample size 1400	15,000	11
Analysis and report	15,000	11

*Based on rates quoted in year 2020. Excludes the survey design cost.

This cost includes: list management, interviewer time, phone costs, quality assurance systems, validation and a participant incentive of $10 to complete the survey.

4.1.3. Advantages and limitations

Surveys are an efficient quantifying behaviours and amount of food waste, as well as assessing the change in a particular behaviour or food waste based on an intervention. Surveys are easy to administer and cost effective, allowing for data to be gathered from a large number of people.

However, surveys will only capture the self-reported information unlike other methods such as observations and ethnographic studies which are closer to seeing actual behaviour and amounts of food waste. Further, as oppose to a kitchen diary, surveys do not only capture real time food. Participants have to think back about their previous week in order to fill the survey. As such, typically, surveys underestimate amount of food waste. An example of a survey developed and used in 2020 is included as Appendix.

4.2. Electronic-diary

4.2.1. How to use an electronic-diary

Following is a summary of the development and implementation of an electronic diary used in Australia in 2020.

Respondents were asked to complete the electronic diary for 7 consecutive days. Waste should be collected and measured, before recording in the electronic diary, at least three times per day to coincide with main eating times. The link to the electronic-diary should work on a computer, tablet or smartphone, though it is encouraged the respondents to fill it out on a computer for optimal viewing. A link to view visual, downloadable instructions should be provided at the start of the diary, and visable again via a pop out window on the first meal of every day. The diary date should be pre-set to the date it is filled in on to minimise errors and effort required by respondents.

A dropdown list of food appears when letters were typed into the 'description of food and drink item' field. The list narrowed down in alphabetical order to match the letters typed in as a 'smart form' and including 'Other – please describe' field allowed free text typing. Food categories (See example in Appendix 2) should be automatically set and linked to the food description chosen. Including a field for 'where disposed of' is helpful to add understanding of behaviours in the household.

4.2.2. Cost per head

The following quote was for a seven day electronic kitchen diary developed and used in 2020.

	Total cost (AUD)*	Cost per head (AUD)*
Sample size 1000	30,000	35
programming the electronic diary	5,000	

A weighing scale (optional)		20
Analysis	6,000	+5

*based on rates quoted in year 2020

4.2.3. Advantages and limitations

The main advantage of the electronic diary is its ability to capture individual products that are wasted and their respective disposal stream. Unlike the survey, electronic diary is able to capture food waste in terms of weight, products and categories as it happened. Electronic diary has to ability to capture why the specific product was disposed (plated leftover, expired etc), the condition in which it was disposed (used, unopened etc.) and the disposal route (compost, bin, fed to pets etc) (Silvennoinen et al., 2014). Although it would increase the cost per person, it is highly recommended participants be required to measure their waste using scales (to capture the amount in kg) rather than other methods (such as estimating number of cups).

However, data is self-reported which reduces the accuracy of information gathered. Further, participants measuring their waste on a daily basis results in an increase in awareness and this may lead to a change in behaviour, such as reducing their waste over the period of data collection. Another disadvantage of a kitchen diary is, compared to a survey it requires more time and effort from the participant as well as the researcher. As such, there could be high attrition rates during the period of investigation.

4.3. Bin audits

4.3.1. How to use bin audits

Measuring actual waste in kerbside collection bins provides a very accurate method and is relatively expensive on a per respondent basis. If using multiple auditors it is important to ensure they use the same audit protocol. In warmer climates it is desirable to account for the weight loss due to decomposition. Audit report should make a note of the seasonal variations. Certain fruits and vegetables that are seasonal could increase the weight of certain categories of food (eg. Use of more Watermelons in summer increase the either waste of fresh fruits or inedible food categories) during the season which could affect the weight of waste if the same audit was done during a different season. Further, festivals (e.g Christmas, Easter) and school holidays should also be avoided when scheduling audits in order to reflect a normal week of a household. The waste collection dates must also be considered when scheduling bin audits. Auditors should ensure waste collection dates don't fall between the bin audit period for each of the household being audited.

4.3.2. Cost per bin

The following quote is for bin audits undertaken in 2020.

No of bins	Total cost (AUD)*	Cost per bin (AUD)*
150	35,000	233
350	73,500	210

*based on rates quoted in year 2020

The costs include: identification of sample including liaising with local council, waste pick-up costs, quality assurance, physical storage, measurement of waste, data entry and disposal. An additional incentive of approximately 40-50 AUD would have to be paid to each participant if they were required to collect their waste over a week for collection by the audit team to reduce high attrition rates. Alternatively, working with the counsils to audit food waste in detail as part of a council waste audit would reduce attrition rates as it removes opt in requirement.

4.3.3. Advantages and limitations

The main advantage of a bin audit is its ability to provide details of actual weight and identification of specific products and/or categories of food waste. However, bin audits do not consider other disposal pathways such as feeding to pets, composting and tipping down the sick. In areas where households have a choice of which bin in which to dispose of food (such as a general waste bin or food and garden organics bin) it would be necessary to audit multiple bins, adding to the cost on a per respondent basis.

5. Comparison of measurement of food waste from the three research tools

5.1. Aim

The objective of this section is to present a comparative analysis of alternative household food measurement tools. Three specific tools will be reviewed: survey, electronic diary and bin audit. These were developed and used in Australia in 2020. The first two tools belong to the self-reported food waste category while the third tool belongs to the waste compositional analysis category. The specific aims of the chapter are to:

- examine the differences in estimates of household food waste obtained from survey, electronic diary and bin audit methods; and
- ascertain the adjustments needed to obtain more accurate estimates when using food waste measurement research tools.

5.2. Methodology

5.2.1. Food waste measurement tools: survey, electronic diary and bin audit

A survey was commissioned by the Fight Food Waste CRC in 2020 to gather a range of data pertaining to household food waste in Australia. The survey comprised a sample of 2885 households drawn from approximately 10,000 invitations to participate. The survey has used Australia's largest online research panel representing all states of Australia. Out of the survey sample, 1462 completed the electronic diary, and a bin audit was carried out in 495 households. Hence those in the bin audit that took part in all three food waste measurement activities. Data collection took place from 10th November 2020 to 21st December 2020 and 30th January 2021 to 16th February 2021.

5.2.2. Recruitment of participants

The initial recruitment for the survey was based on self-selection from being on the online research panel and then several qualifying criteria were applied. These included food planning and provisioning responsibility at home and the time period the respondent was at home the week prior to the survey. To qualify for the survey, the respondent had to be mainly or jointly responsible for food management at home and at home four nights or more in the week prior to the survey. Further, participants had to not be in a Food Organics and Garden Organics (FOGO)bin area, have their own bin, and agree to have their waste bin physically audited.

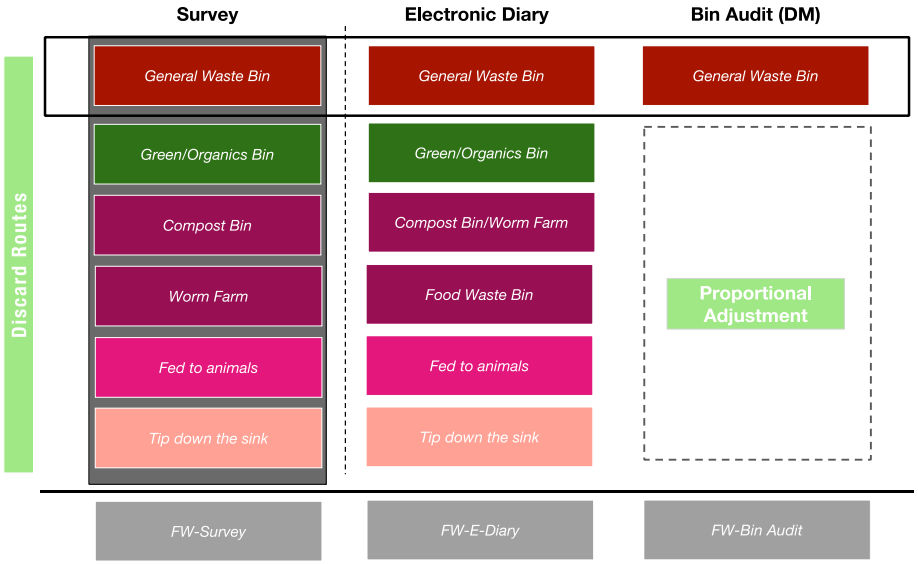
5.2.3. Sample Profile

The survey sample closely resembled the Australian population in terms of household structure, household income, age and gender. In particular, the sample were weighted to adjust for differences in population in each State and Territory. A few deviations from the Australian population were found in age (18–34-year-olds) and household structure (households living alone) were both slightly under-represented, and the lowest income group (<$1000 per week) was slightly over-represented in the survey sample.

5.2.4. Survey Questions

The 15-minute online survey comprised of several sections including initial screening questions, contextual and food behaviour questions, food waste questions and socio-demographic questions. The section on food disposal comprised of 15 individual food categories with a few examples for each category (Refer Karunasena & Pearson, 2021 and Karunasena *et al*. 2021 for more details).

5.2.5. Methods of food waste measurement comparison



Note: The bottom grey boxes represent total food waste from all discard routes for each method. FW-Food Waste; DM – Direct Measurement

Figure 9: Food waste measurement methods

Figure 9 illustrates the food waste measurement tools analysed in this report and the associated discard routes measured for each tool. The bin audit covered only a single disposal route – general waste bin ("Red bin") whereas the electronic diary covered a comprehensive list of all food waste disposal routes including green organics bin, compost bin, tipping down the sink and feeding to pets/animals.

Several types of analyses were carried out. First, a comparison of electronic diary and bin audit. An important requirement of food waste comparison of methods is that the discard routes must be common to the methods compared (Quested et al., 2020). Since the general waste data can be extracted from the electronic diary, it can be compared to bin audit's general waste values. However,

food waste data were not collected by the individual discard route in the survey and therefore, these values cannot be directly compared with bin audit values. The comparison of survey food waste measurement with the other two methods is discussed in the next section.

Analyses of methods that compare household food waste measurement tools are virtually non-existent in the literature at the time of writing this report. At the time of writing this report, there were only two studies that directly addressed the issue. The first study, conducted by van Herpen and colleagues, compared five food waste measurement methods – survey, food waste diary, survey with in-home observations and photo recording, waste compositional analysis and kitchen caddies (van Herpen et al., 2019). In addition to mean and standard deviation, the study used statistical testing (ANOVA) and correlations on the food waste quantities of recorded to compare methods. It also analysed the level of difficulty of participating in each method.

The second study by Quested et al. (2020) compared surveys and food waste diaries using data from five separate studies. They have used the below equation to define the Degree of Underestimation (DoU) in a particular food waste measurement method. To compare electronic diary and bin audit food waste values, the below equation can be used:

$$\textit{Degree of under-estimation} = \frac{\mu_{\textit{Bin-Audit}} - \mu_{\textit{E-Diary}}}{\mu_{\textit{Bin-Audit}}}$$

where $\mu_{\mathrm{Bin-Audit}}$ indicates the mean food waste value obtained from bin audit and $\mu_{\mathrm{E-Diary}}$ represents the mean food waste value obtained from the electronic diary measurement tool. NRDC (2017) used a slightly different equation to calculate the Degree of Difference (DoD):

$$\textit{Degree of Difference} = \frac{\mu_{\textit{Bin-Audit}} - \mu_{\textit{E-Diary}}}{\left(\mu_{\textit{Bin-Audit}} + \mu_{\textit{E-Diary}} / 2\right)}$$

The Degree of Under-estimation is typically expressed as a Scaling Factor that can be used to make adjustments to food waste values. The Scaling factor (Quested et al. 2020) can be expressed as:

$$Scaling\ Factor = \frac{1}{(1 - Degree\ of\ Underestimation)}$$

This report uses the above indicators and statistical methods to compare measurement methods.

6. Findings

6.1. Comparing the electronic diary and bin audit methods

A comparison of electronic diary and bin audit food waste measurement was carried out. Electronic diary data were collected according to the waste disposal route and therefore, the food discarded through the general waste bin route was suitable for comparing with physical bin audit. The box plots of electronic diary and bin audit food waste are shown in Figure 10. The analysis resulted an average of 1.50 kg per household per week and 1.78 kg per household per week for electronic diary and bin audit, respectively. Welch t-test confirmed that the mean food waste difference was statistically significant (Statistic = 2.64, p = 0.008). This finding confirms the established research that electronic diary underestimates household food waste (Quested et al., 2020, Withanage et al., 2021).

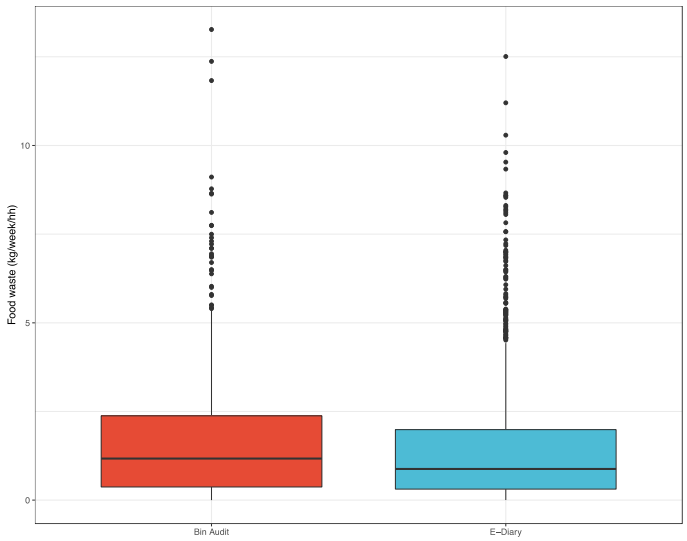


Figure 10: Boxplots of food waste sent to general waste bin from electronic diary and bin audit

It is imperative to consider the food disposal route captured by each measurement method when making comparisons. In this study, both Benchmarking Survey and Electronic Diary captured all waste discard routes while the Bin Audit only captured the food discarded through waste bin or 'red bin'. Accordingly, comparisons can be made (a) focusing solely on waste bin disposal route and (b) focusing on all disposal routes. This section focuses on waste bin disposal route and section 6.8 focuses on all disposal routes and includes the Benchmarking survey also in the comparison.

Since general waste comprises a fraction of total food waste, the focus of the analysis was the level of under/over estimation. Accordingly, the degree of underestimation and scaling factor were calculated using the methodology presented in section 5.2.5. The waste bin comparison analysis resulted a 16% underestimation of food waste in electronic diary with reference to the bin audit food waste value. The general consensus in the literature is that direct measurement of food waste (via bin audits) is more accurate than any other self-reported measures (Jörissen et al., 2015). The DoU translates into a scaling factor of 1.2, which implies that an average food waste calculated using electronic diary should be adjusted upwards or multiplied by a factor of 1.2 to derive a relatively accurate estimate of household food waste (Table 13).

Table 13: Degree of Underestimation and Scaling factor for electronic diary compared to bin audit (Disposal route: General Waste bin)

	Bin audit	Electronic diary
Sample size	**495**	**1462**
Weight of waste	1.78 kg	1.50 kg
Degree of Underestimation		16%
Scaling Factor		1.2
Sample size	**409**	**409**
Weight of waste	2.03 kg	1.89 kg
Degree of Underestimation		7%
Scaling Factor		1.07

It should be noted DoU of 16% based on two independent samples of 1462 observations in the electronic diary and 495 observations in the bin audit. A paired sample (n = 409) was constructed by matching households who took part in both electronic diary and bin audit, which, yielded a slightly lower DoU (7%) and a Scaling Factor (1.07). This is due to the reduced variability of the measurement. For instance, the selection bias is the same for both measurement methods, thus eliminating the associated variability. It should also be noted that the analysis only included food discarded through general waste bin, which further minimises variability of the measurement. Further discussion on DoUs is presented in section 6.8.

6.2. Proportion of households under- and over-estimation

The extent of under- and over-estimation in electronic diary was assessed by subtracting bin audit food waste values from the electronic diary values. Figure 11 presents the histogram of the difference in food waste value of the two measurement methods. The distribution closely resembles a normal distribution, and it is important to note that almost half of the households (44.2%) and a similar proportion (55.8%) of households over-estimate food waste in electronic diary. However, the magnitude of overestimation is much larger as can be seen from the large positive values on the horizontal axis of Figure 11. The level of under- and over-estimation is comparable to other studies. For example, in a self-assessed and measured food waste comparison, Elimelech et al. (2019a) reported that 46% of the participants underestimated their household food waste while 48% overestimated it.

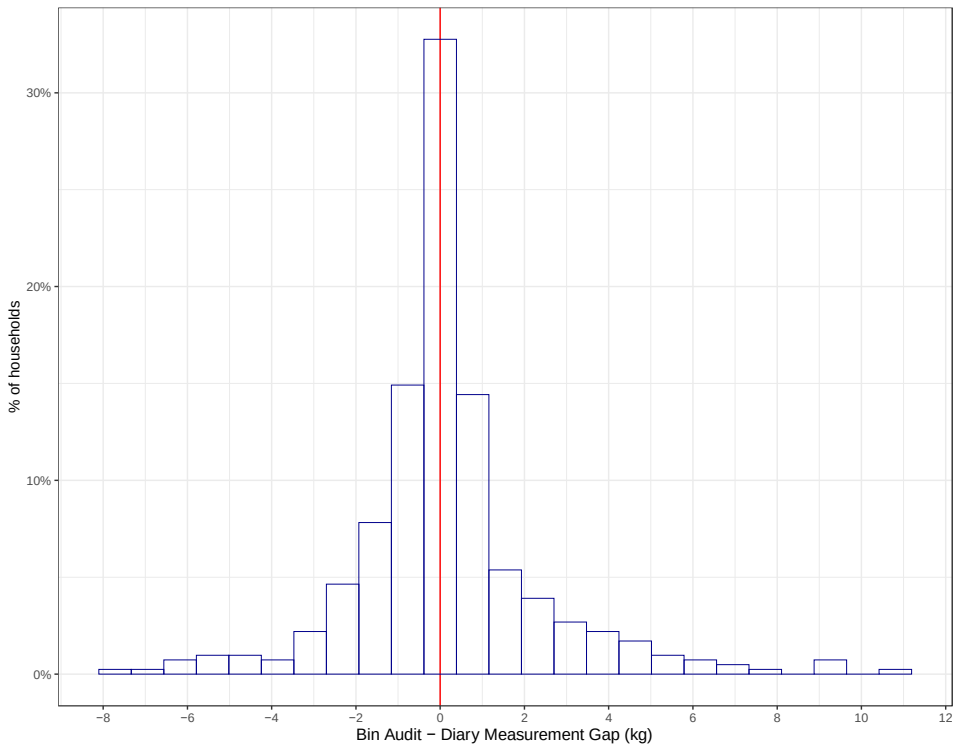


Figure 11: Histogram showing the proportion of households under/over estimating food waste in Electronic Diary

6.3. Comparing the survey, electronic diary and bin audit methods

To compare the survey method with the other two methods, a conversion factor of 0.42 was used to adjust bin audit food waste mean value (1.78 kg). This conversion factor was based on electronic diary data which showed that on average 42% of total food waste is discarded through the general waste

bin. Figure 12 depicts the scatterplots of food waste values obtained from three methods. Table 14 presents the descriptive statistics of food waste data for the three methods.

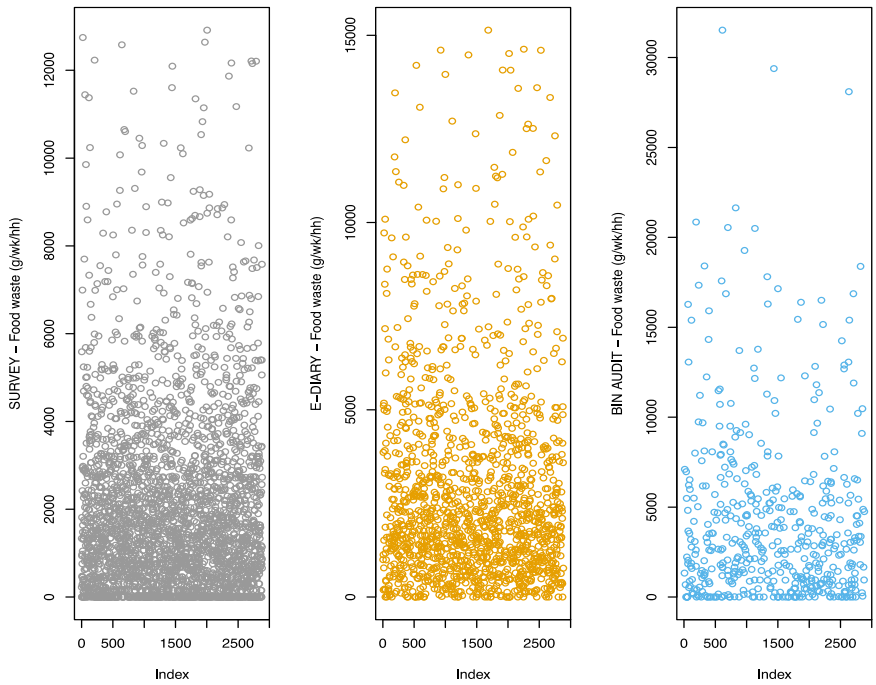


Figure 12: Scatterplots of food waste data by measurement method

Table 14: Descriptive statistics of food waste from self-reported measurement tools

Method	Mean	SD	Median
Survey	2.04	2.08	1.46
Electronic diary	2.89	2.74	2.04
Calculated food waste	3.4*		

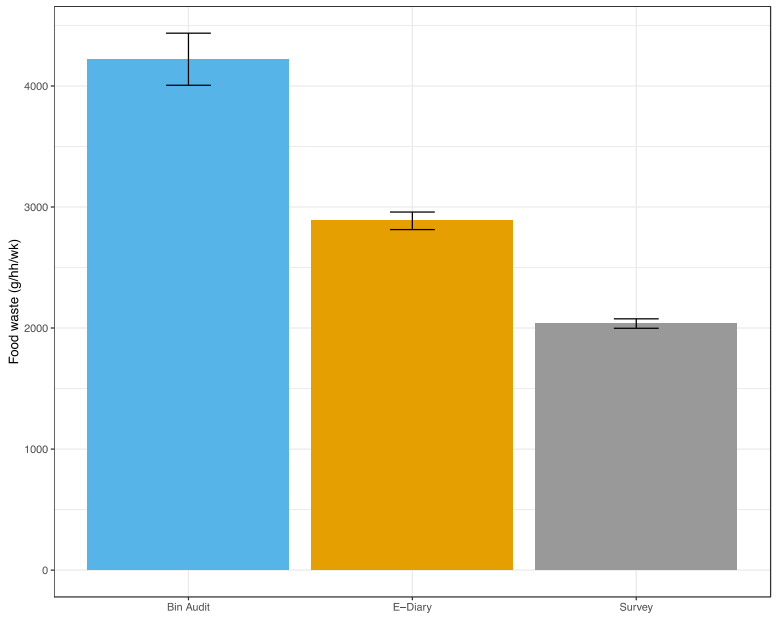
*Adjusted value.

The mean food waste values for survey and electronic diary were 2.04 kg and 2.89 kg. Table 14 shows that survey and electronic diary reported lower levels of food waste compared to bin audit. This is consistent with the existing literature (Withanage et al., 2021). The average food waste estimated by the survey, in particular, showed a substantial difference compared to the average food waste value estimated by the bin audit. Using electronic diary food waste value and the scaling factor of 1.2 (Table

13), the bin audit food waste value of 3.4 kg (adjusted) is calculated considering all waste disposal routes. The implicit assumption in this adjustment is that households underestimate food discarded through waste bin and all other disposal routes in the same magnitude . According to the electronic diary, the average food discarded through non-waste bin diposal routes is 1.39 kg (2.89 – 1.5 = 1.39 kg). Applying a scaling factor of 1.2 to this amount and adding that to original bin audit value yield a calculated food waste value of 3.4 kg.

6.4. Calculation of standard errors of mean

Bar plots of mean food waste values with standard errors are presented in Figure 13. Standard errors indicate the uncertainty around the estimate. It should be noted that the bin audit had the largest standard error compared to the other two methods[7]. An ANOVA was carried out to test the statistical significance of food waste means obtained from the three methods. The results confirmed that there are statistically significant differences between means ($F = 157.7$, $p < 0.05$). It also provided an effect size of 0.062 implying that 6.2% of the change in mean food waste value can be accounted to the measurement method. Post-hoc Tukey test was carried out to examine the measurement differences pairwise and the results revealed that all three pairwise comparisons are statistically significant at $p < 0.001$.



Note: Error bars represent standard errors of the mean

Figure 12: Boxplots of food waste from the three measurement methods

[7] Note that the adjusted bin audit value used here is based on the overall proportional weight of waste bin.

6.5. Calculation of coefficient of variation

To assess the variation around the mean, the Coefficient of Variation (CV) is calculated for the three methods (Figure 14) by dividing the standard deviation by mean. Electronic diary showed the lowest variability while bin audit had the highest variability across food waste values recorded by participants. This implies that the bin audit may be better able to distinguish between high and low food wasters and this distinction is low for electronic diary.

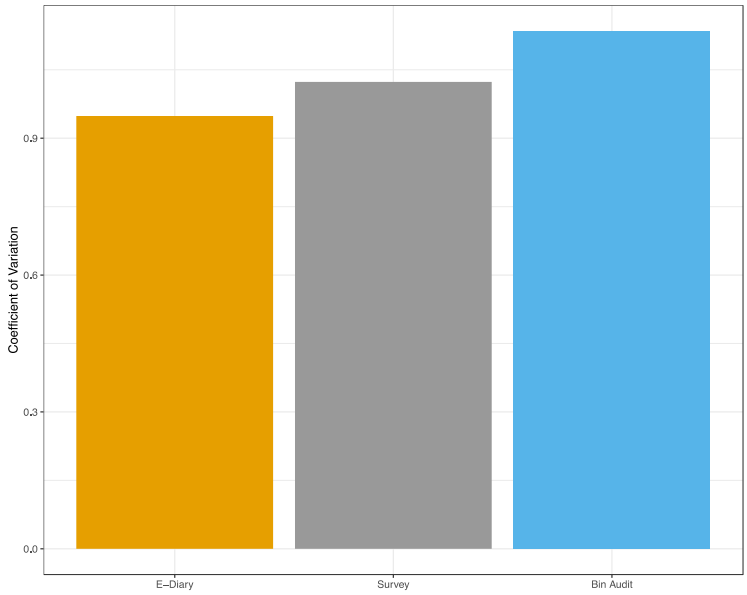


Figure 14: Coefficient of variation (SD/Mean) showing the relative variability in food waste values

6.6. Correlation between measurement methods

The correlation between various measurement methods indicates how closely the food waste values are linked to each other. Pearson correlation coefficient for each pair of method was calculated. Figure 15 summarises the results of correlation analysis. The upper diagonal values are Pearson correlation coefficients. Food waste values all three methods indicated a positive and weak correlation with each other. The coefficients were statistically significant at $p < 0.01$ level.

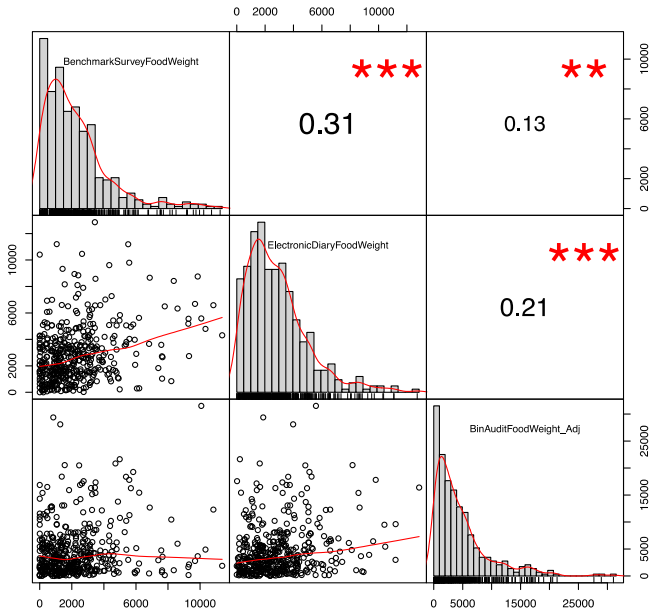


Figure 15: Scatterplot matrix showing histograms of food waste, correlation coefficients and their statistical significance

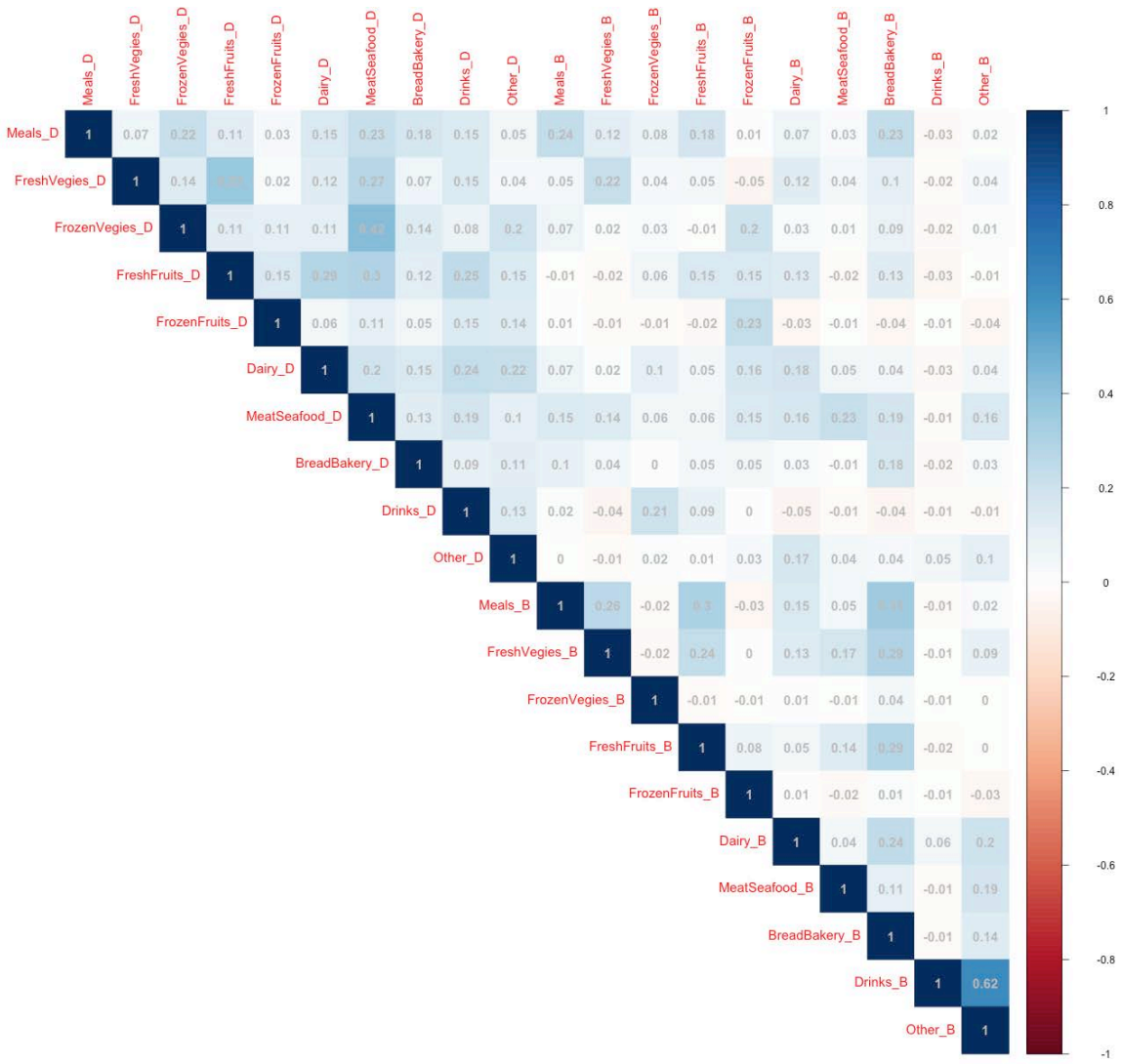
The correlation coefficient between the two self-reported methods (survey and electronic diary) was 0.31 while their correlation coefficients with the measured food waste – bin audit - were 0.13 and 0.21 respectively. The above weak correlation between the self-reported and measured food waste is not unique. For example, Elimelech et al. (2019b) found a weak and statistically significant positive correlation (0.18) between self-reported and measured food waste. In contrast, in a study conducted in the Netherlands, van Herpen et al. (2019) reported a moderate positive correlation between self-reported and measured methods. Specifically, the study found a correlation coefficient of 0.36 between kitchen caddies (n = 46) and survey (self-reported waste through a survey), 0.35 between kitchen diary (n = 94) and survey and 0.86 between diary and caddies (van Herpen et al., 2019).

The substantial discrepancy in correlation coefficients between methods highlight the difficulty in making comparisons because of the nontrivial differences in measurement design and implementation. For example, kitchen caddies were supplied to the participants in the Netherlands study. These caddies consisted of two bins each with two compartments, separating waste according to the state of the waste. The researchers collected the bags in every two or three days for weighing. Moreover, the sample size is relatively small compared to the present study in which 495 household took part in the kerbside bin audit and over 1400 in other two methods. In the present study, participants accumulate their food waste in a separate bag over a 7-day period and at the end of the 7-day period, the food waste bags were picked up and measured by bin auditors.

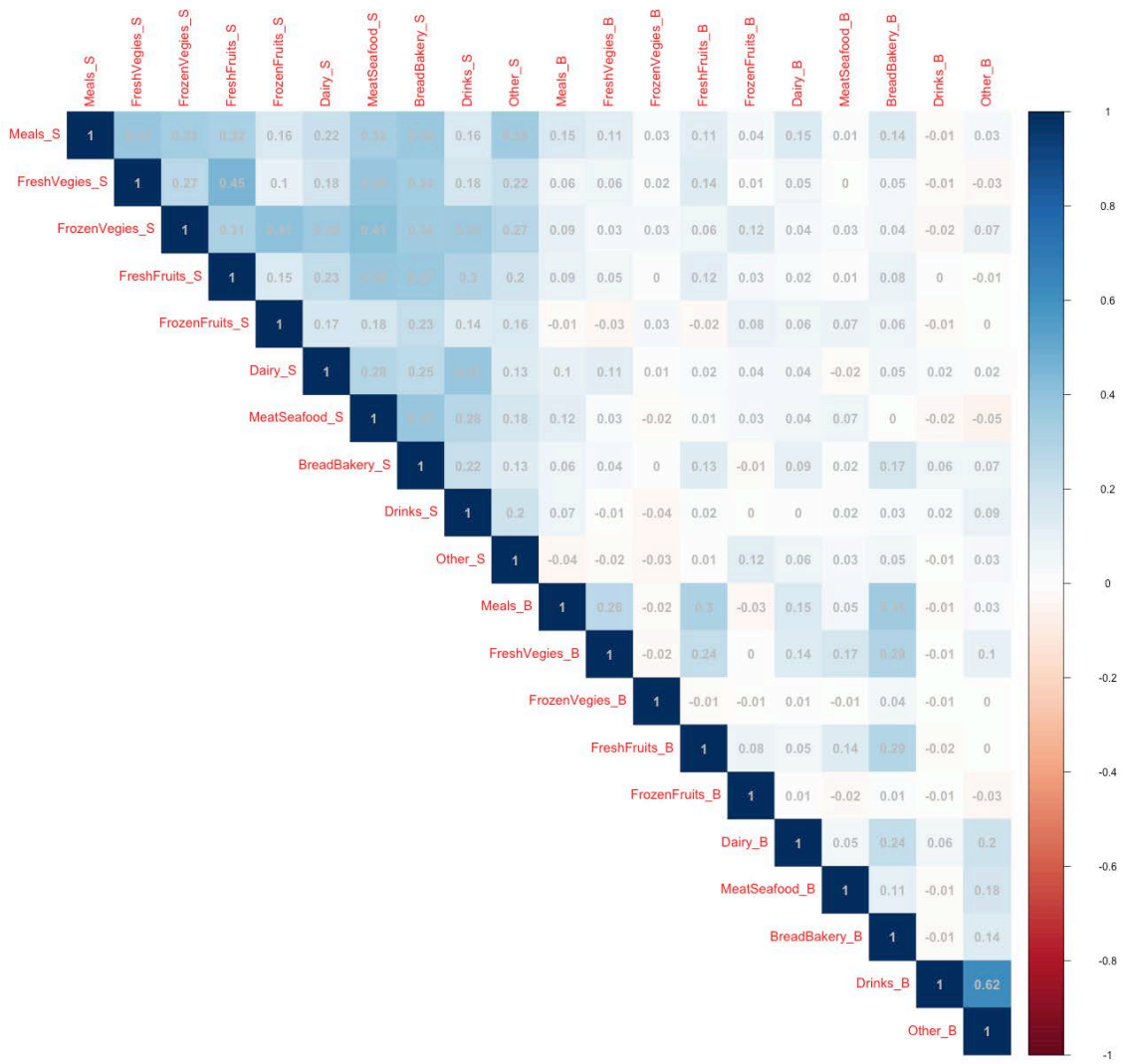
6.7. Correlations between food waste categories

Pearson correlation coefficients were calculated by pairing ten food waste categories as measured by the three methods and are shown in Figure 16 (a) and (b). The dark boxes on diagonals represents the correlation coefficients (1.0) of own values and positive correlations are shown in blue and negative ones are in orange colour. It demonstrates relatively higher correlations among food categories in the survey compared to electronic diary. This again confirms the less variability in the survey food waste values. The correlations among food waste categories of different methods were weak but mostly positive. For example, the correlation coefficient between meal waste values of electronic diary and bin audit was 0.24 implying a weak positive correlation.

(a) Electronic diary and bin audit food categories



(b) Survey and bin audit food categories



Note: The values are correlation coefficients. The food category label extensions D, B and S represent electronic diary, bin audit and survey, respectively

Figure 16: Correlations among the food categories as measured by the three methods.

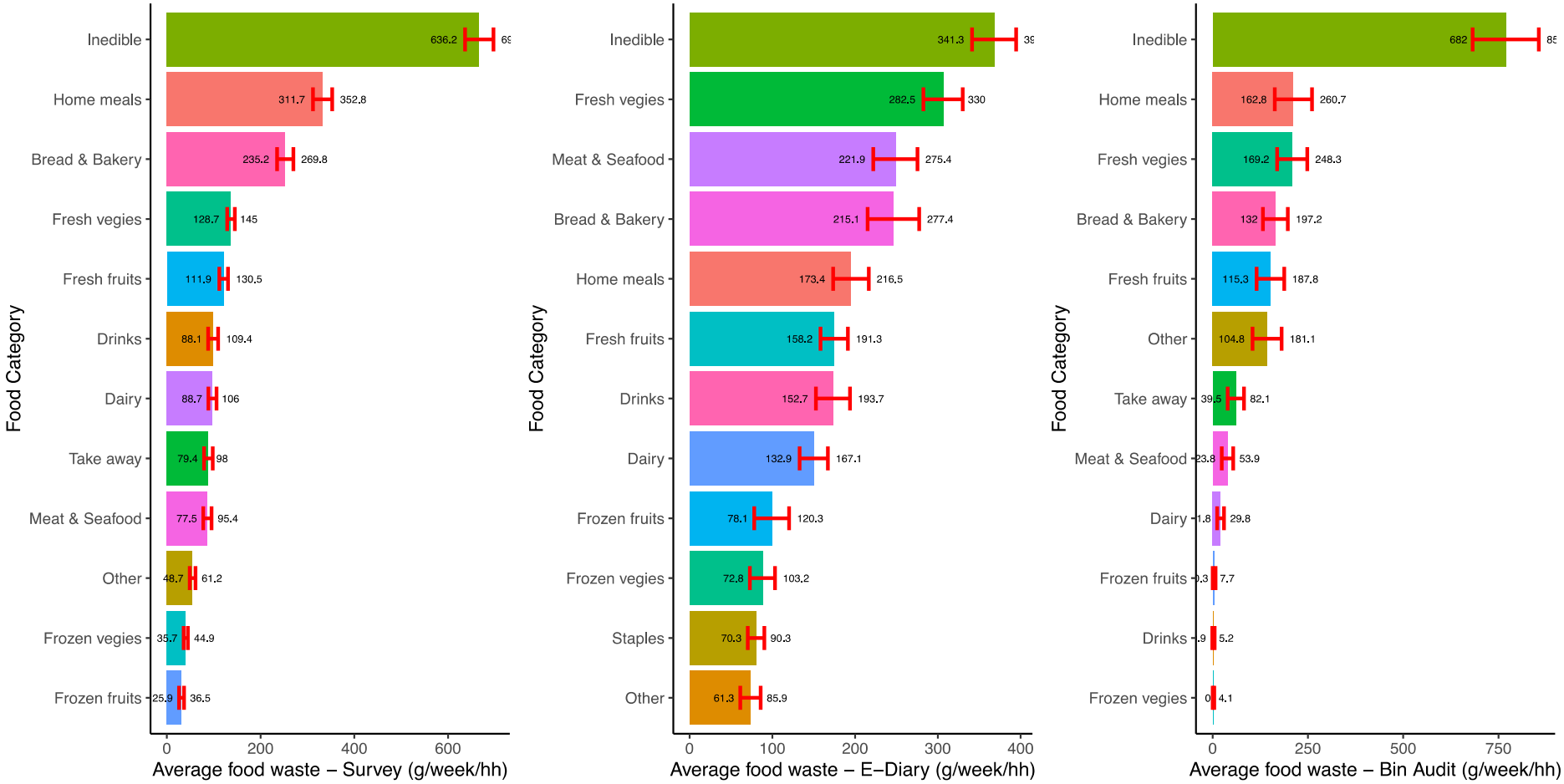


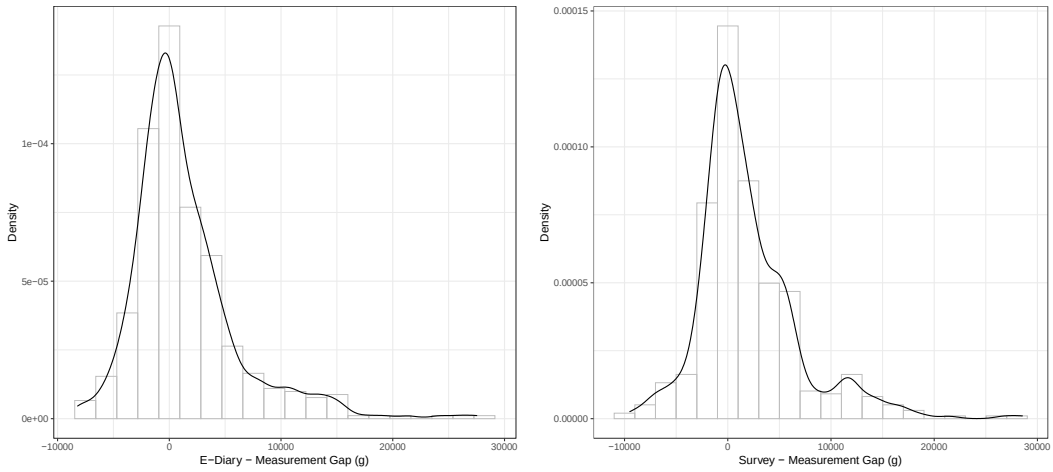
Figure 17: Average household food waste by food categories as measured by survey (Survey), E-Diary (electronic diary) and bin audit

Note: The values on the bars represent the lower and upper levels of the confidence interval. The bin audit x-axis scale is different to the other two.

Figure 17 shows the average food waste by food waste categories with confidence intervals. Overall, survey food waste categories showed the least variation in terms of level of uncertainty in the measurement. This reiterates the earlier notion that survey may not adequately pick up very high/low food wasters compared to the other two methods. Inedible food waste category demonstrated relatively high uncertainty of measurement in both electronic diary and bin audit methods. In electronic diary, bread and bakery food category depicted a relatively higher uncertainty compares to the other food categories.

6.8. Degree of Underestimation

Following the methodology explained in section 5.2, the Degree of Underestimation (DoU) between the direct measurement (bin audit) and two self-reported methods (electronic diary and survey) was calculated. It should be noted that bin audit food waste average has been adjusted to reflect total food discarded as opposed to food discarded into the general waste bin. The Degree of Underestimation in survey was 41% compared to the kerbside bin audit, which implies a scaling factor of 1.7. A slightly higher proportion of households (60.7%) underestimated food waste in the survey compared to electronic diary (55.2%) (Figure 18).



Note: Electronic diary underestimation 55.2%, survey underestimation 60.7%.

Figure 18: The proportion of households underestimating food waste

Table 15 summarises the results of electronic diary underestimation with some international comparisons. The degree of underestimation in the electronic diary (all discard routes) in comparison with Calculated food waste was 15% yielding a scaling factor of 1.5. Although international comparisons should be made with caution, the DoU estimated for the present study is well within the

range of DoU reported in studies conducted in other countries (7% - 40%). Quested et al. (2020) recommends using both ends of the range (7% and 40% underestimations leading to scaling factor of 1.08 and 1.66, respectively) to reflect the uncertainty associated with scaling factors.

Table 15: A comparison of Degree of Underestimation (DoU) in food waste diaries compared to bin audits (All disposal routes)

Study	Diary	Bin audit	DoU	DoD
Current Study	2.89	3.4	15%	16%
WRAP (2009), UK*	2.18	3.63	40.0%	50.0%
WRAP (2013), UK*	1.89	2.69	30.0%	35.0%
NRDC (2017), USA*	1.89	2.95	36.0%	44.0%
Oregon (2018), USA*	2.99	3.23	7%	8%

*Sourced from Quested et al. (2020); Note DoD – Degree of Difference

6.8.1. Underestimation by household and occupancy types

Figure 19 shows the degree of underestimation by household type for both electronic diary and survey food waste estimation. Nine different household types were specified: households of unrelated people, couples with children aged 18+ years, couples with children under 17 years, single parents with children aged 18+ years, single parents with children under 17 years, empty nesters (couples where children have left home), single and other households. The largest underestimation (>60%) was recorded in households of 'unrelated' people followed by the 'other' category.

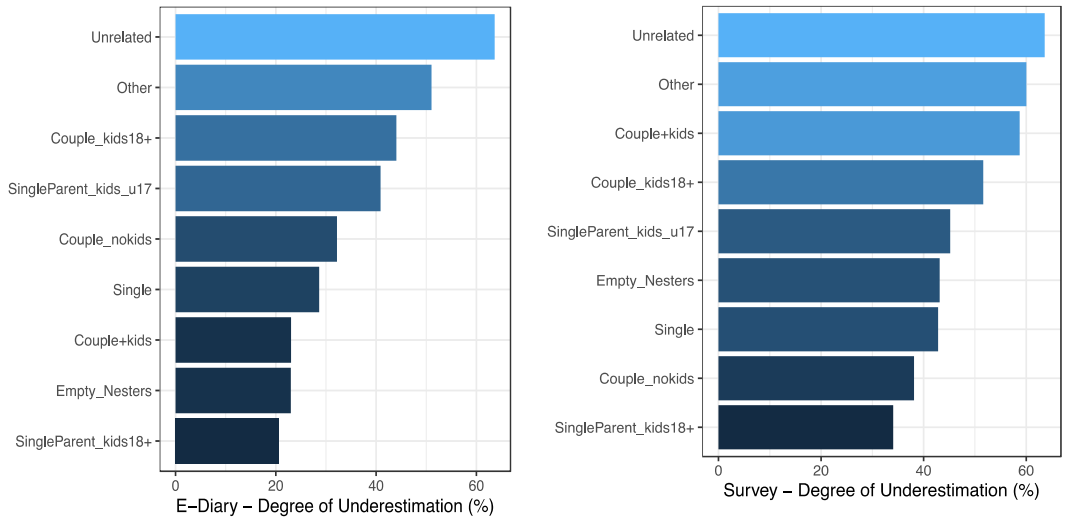


Figure 13: Degree of underestimation by household type

Figure 20 shows the degree of underestimation by occupancy type. For electronic diary, households in flats/units and semi-detached dwellings tend to underestimate more than households residing in stand-along houses and other dwelling types. No such distinction was found in the survey.

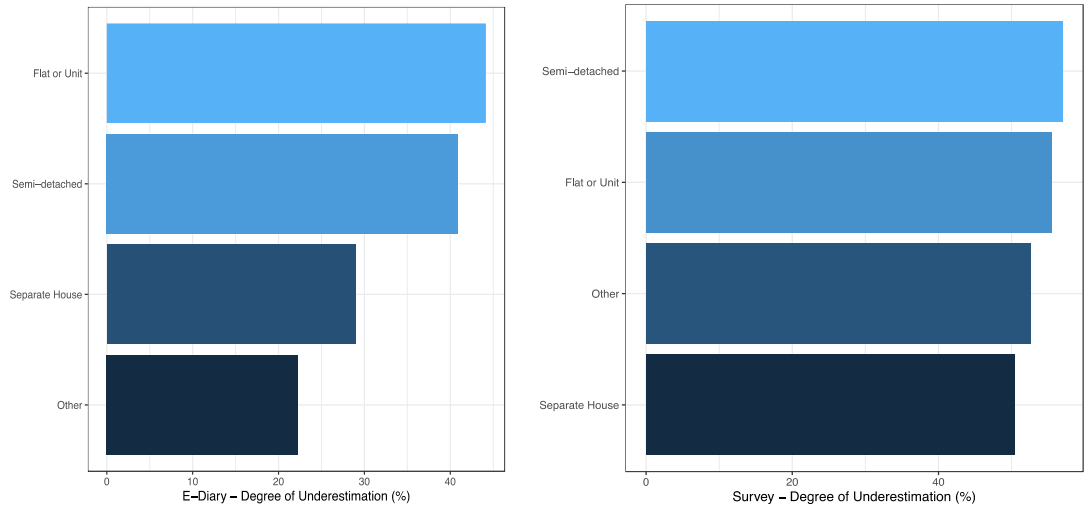
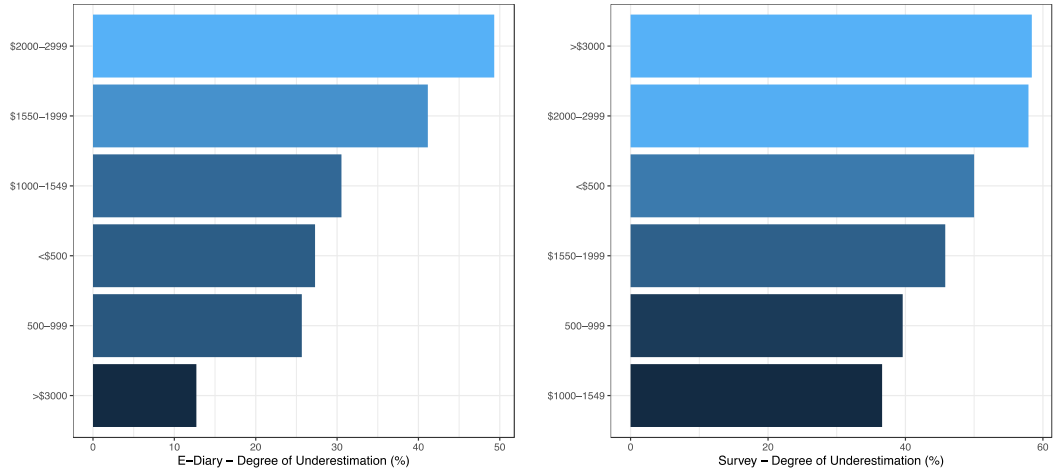


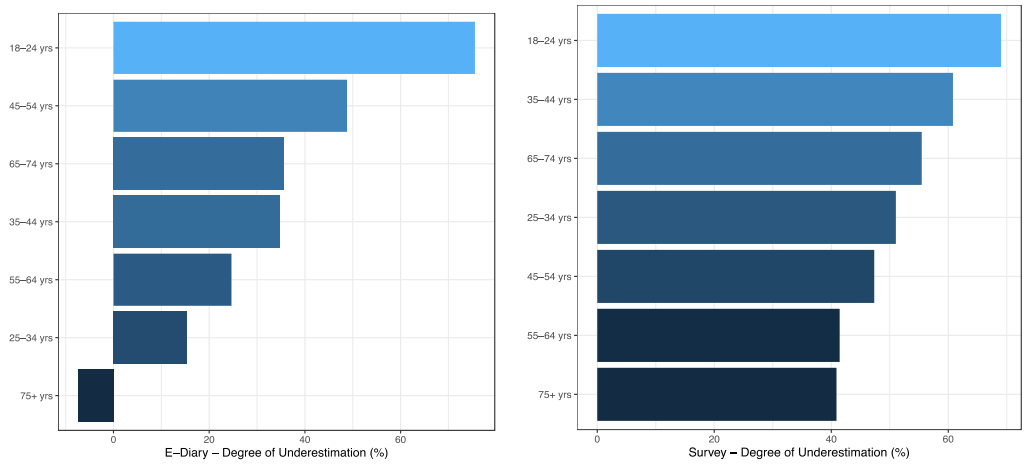
Figure 20: Degree of underestimation by occupancy type

6.8.2. Degree of underestimation by age, gender and income

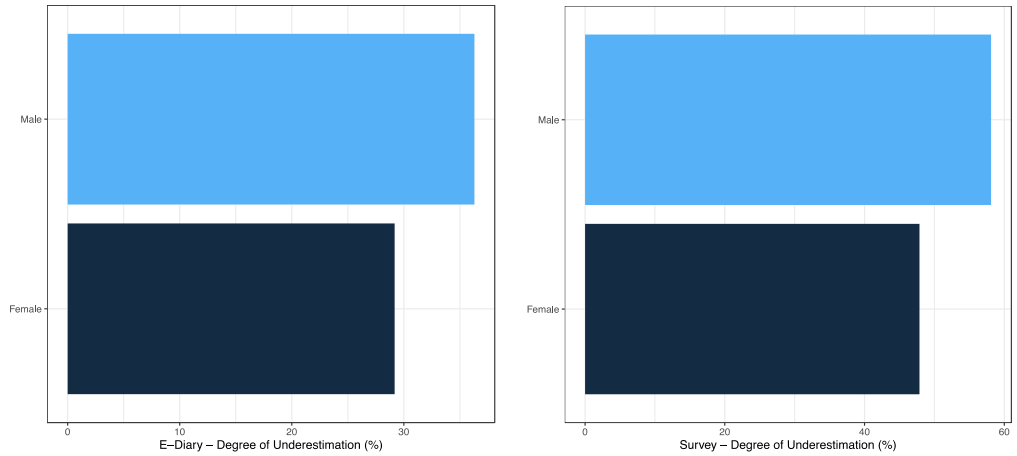
As shown in Figure 21, households with higher incomes tend to underestimate food waste in both methods. The younger households (18-24 years) underestimated the highest whilst 75+ year-olds overestimated food waste in electronic diary. With regard to gender differences, males tend to underestimate food waste more than females in both methods.



(a) Household income



(b) Age



(c) Gender

Figure 21: Comparisons of electronic diary and survey underestimations (DoU) by socio-demographic factors

6.9 Summary of findings

This section presented an analysis of food waste as measured by the survey, electronic diary and bin audit. Comparisons were made between methods including the estimations of DoUs and scaling factors. Finally, the degree of underestimation in the survey and electronic diary was explored using socio-demographic factors. Based on the analysis, the following conclusion can be made:

- Food waste at home can be measured in multiple ways and all methods have their strengths and limitations.
- Food waste measurement comparisons must be made with utmost caution because of the complexities involved in separating waste streams, communicating what constitutes as 'food waste' and inherent biases associated with each method.
- There were statistically significant differences among the average food waste estimates as measured by the three methods.
- Self-reported food waste measurement methods – survey and electronic diary underestimate household food waste compared to direct measurement – bin audit.
- The degree of underestimation is a relative measure to compare food waste measurement tools. The degree of underestimation is lower in electronic diary method compared to survey.
- Bin audit had the largest standard error compared to electronic diary and survey, implying that there is uncertainty around physical food waste measurement.
- The analysis of coefficient of variation in the three measurement methods revealed that electronic diary had the lowest variation whilst bin audit had the highest variation among the methods. This suggests that bin audit has a higher ability to pick up high and low food wasters compared to the other two methods.
- The analysis of underestimation between bin audit and electronic diary revealed that although a similar proportion of households both underestimate and overestimate food waste, the magnitude of underestimation is greater than overestimation in electronic diary.
- The degree of underestimation between food waste values ranged from 7% for electronic diary (general waste bin discard route and paired sample), 16% for the electronic diary (general waste bin discard route), 15% for electronic diary (all discard routes) to 40% for the survey (all discard routes). All comparisons were made with reference to bin audit values.

- Scaling factors ranged from 1.07 for electronic diary (general waste bin route and paired sample), 1.2 for electronic diary (all waste disposal routes) and 1.7 for the survey (all waste discard routes) and they can be used to adjust average food waste values where appropriate. The wide range in the scaling factors is also indicative of the inherent uncertainty when applying scaling factors.
- Scaling factors are sensitive to the nature of comparison i.e., whether the sample size is the same or not and whether it is applied to the same disposal routes or not. Typically, they are applied to aggregate measures and not to individual households.
- The food waste measurement methods analysed in this report were weakly correlated. Survey food categories showed a slightly higher positive correlation compared to electronic diary and bin audit food categories.
- There is no 'golden standard' to compare disparate household food waste measurement methods (van Herpen et al., 2019). However, scholars widely agree that physical measurements such as kerbside bin audits and kitchen caddies yield more accurate results than self-reporting measurement tools.

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8. Appendices

9.1. Survey

Introduction

Welcome. Thank you for participating in this study about food in your home.

1 Do you agree to participate and answer all questions honestly?

DO NOT ROTATE	S/R	
Yes	◯1	CONTINUE
No	◯2	THANK AND CLOSE

Screening questions

Thank you for agreeing to participate. We just need to check some details with you to make sure they match with the types of people we need to speak to.

S1 Please indicate which of the following age groups you belong to:
Choose one of the following:

DO NOT ROTATE	S/R	
17 or under	◯1	THANK AND CLOSE
18-24	◯2	CHECK QUOTAS
25-34	◯3	CHECK QUOTAS
35-44	◯4	CHECK QUOTAS
45-54	◯5	CHECK QUOTAS
55-64	◯6	CHECK QUOTAS
65-74	◯7	CHECK QUOTAS
75+	◯8	CHECK QUOTAS

S2 Please enter your Postcode:
Only numbers may be entered in this field.

S3 Just thinking about the last 7 days, were you personally away from home for three nights or more?

Please choose one answer

DO NOT ROTATE	**S/R**	
No- I was **not** away from home for three nights or more	◯1	CONTINUE
Yes- I was away from home for three nights or more	◯2	THANK AND CLOSE
Don't know / prefer not to say	◯99	THANK AND CLOSE

[ASK ALL]

S4 To what extent do you contribute to the following in your household:

Please do not include alcohol when answering any of the following questions.

Please choose one answer that fits best for each stage of the food handling process

		S4.1	**S4.2**	**S4.3**	**S4.4**	**S4.5**
	DO NOT ROTATE	**Planning** for food shopping	**Doing** the food shopping	**Unpacking and storing** the food	Doing the **food preparation including cooking**	**Disposing** of food not eaten
		S/R	**S/R**	**S/R**	**S/R**	**S/R**
[**MUST CODE 1 OR 2** FOR S4.1 or S4.2 or S4.3 or S4.4 or S4.5 for **AT LEAST 3 ACTIVITIES]** **[RECRUIT A SPREAD OF CODES, FROM ONLY MAINLY RESPONSIBLE FOR ONE ACTIVITY, TO MANY]**	I'm mainly responsible	◯1	◯1	◯1	◯1	◯1
	I'm equally responsible	◯2	◯2	◯2	◯2	◯2

	I'm partly responsible	◯3	◯3	◯3	◯3	◯3
	I'm not responsible/ I'm rarely responsible.	◯4	◯4	◯4	◯4	◯4

MAIN SURVEY

SECTION A: FOOD PLANNING, PURCHASING, STORAGE, PREPARATION, LEFTOVERS and DISPOSAL

[ASK ALL] - **Planning**

A1 Before **going shopping for food**, how often do you, or other members of your household, do the following?
Please choose one answer in each row

	ROTATE STATEMENTS	Almost every time (over 90%)	Most times (about 75%)	Half the time (about 50%)	Sometimes (about 25%)	Rarely / Never (less than 10%)	Don't Know/Not applicable
A	Check what food is already in the **cupboard**	◯5	◯4	◯3	◯2	◯1	◯99
B	Check what food is already in the **fridge/freezer**	◯5	◯4	◯3	◯2	◯1	◯99
C	**Plan** the meals to be cooked	◯5	◯4	◯3	◯2	◯1	◯99
D	Plan for the **quantities of ingredients** needed to prepare meals I planned	◯5	◯4	◯3	◯2	◯1	◯99
E	Write a **list** of **basic** essentials	◯5	◯4	◯3	◯2	◯1	◯99
F	Write a complete **list** of **everything** needed	◯5	◯4	◯3	◯2	◯1	◯99

[ASK ALL] - **Purchasing**

A2 When doing the **main food shopping**, **how often** do you, or other members of your household, do the following?
Please choose one answer in each row

	ROTATE STATEMENTS	Almost every time (over 90%)	Most times (about 75%)	Half the time (about 50%)	Sometimes (about 25%)	Rarely / Never (less than 10%)	Don't Know/Not applicable
A	Only buy what is on the shopping **list**	◯5	◯4	◯3	◯2	◯1	◯99
B	Buy food based on what is on **'special'**	◯5	◯4	◯3	◯2	◯1	◯99
C	Check the **'use by' or 'best before'** dates before purchasing food items	◯5	◯4	◯3	◯2	◯1	◯99
D	Buy food for '**just in case**'	◯5	◯4	◯3	◯2	◯1	◯99

[ASK ALL] - **Storage**

A3 When **storing food**, how often do you, or other members of your household, do the following?
Please choose one answer in each row

	ROTATE STATEMENTS	Almost every time (over 90%)	Most times (about 75%)	Half the time (about 50%)	Sometimes (about 25%)	Rarely / Never (less that 10%)	Don't know / Not applicable
A	Read the **instructions** provided on packages before storing	◯5	◯4	◯3	◯2	◯1	◯99
C	Move the oldest food items to the **front or top** so that they can be used first	◯5	◯4	◯3	◯2	◯1	◯99
D	Use storage **containers** to keep food for as long as possible	◯5	◯4	◯3	◯2	◯1	◯99
E	Put food in the **fridge/ freezer** so it **keeps** for as long as possible	◯5	◯4	◯3	◯2	◯1	◯99

F	Keep the **temperature** in the **fridge** below 4° C and **freezer** below -18° C	◯5	◯4	◯3	◯2	◯1	◯99
G	Find it hard to fit food into the **fridge/freezer** because it's **already full**	◯5	◯4	◯3	◯2	◯1	◯99

[ASK ALL] – **Preparation**

A4 When **preparing food**, how often do you, or other members of your household, do the following?
Please choose one answer in each row

	ROTATE STATEMENTS	Almost every time (over 90%)	Most times (about 75%)	Half the time (about 50%)	Sometimes (about 25%)	Rarely / Never (less than 10%)	Don't Know/Not applicable
A	Try to use up the **oldest** food first	◯5	◯4	◯3	◯2	◯1	◯99
B	**Aim not to** have any leftovers	◯5	◯4	◯3	◯2	◯1	◯99
C	Think carefully about **quantities needed** before preparing a meal	◯5	◯4	◯3	◯2	◯1	◯99
D	**Measure ingredients** for a meal	◯5	◯4	◯3	◯2	◯1	◯99
E	Prepare **extra food just in case** it is needed	◯5	◯4	◯3	◯2	◯1	◯99
G	Let **others serve** themselves	◯5	◯4	◯3	◯2	◯1	◯99

[ASK ALL] - **Leftovers**

A5 **Leftovers** occur when some prepared food is not eaten, how often do you, or other members of your household, do the following?
Please choose one answer in each row

		Almost every time (over 90%)	Most times (about 75%)	Half the time (about 50%)	Sometimes (about 25%)	Rarely / Never (less than 10%)	Don't Know/Not applicable

A	Prepare food which is not eaten, and **dispose of** these leftovers **straight away**	◯5	◯4	◯3	◯2	◯1	◯99
B	Prepare food which is not eaten, store these leftovers, and **end up eating them**	◯5	◯4	◯3	◯2	◯1	◯99
C	Prepare food, which is not eaten, store these leftovers, and end up **disposing of them**	◯5	◯4	◯3	◯2	◯1	◯99
D	Use leftovers to **create new dishes**	◯5	◯4	◯3	◯2	◯1	◯99

[ASK ALL] - **Disposal**

A6 In relation to the **reasons why food is not eaten** in your household, and hence needs to be disposed of, how much do you agree with the following?
Please choose one answer per row

	DO NOT ROTATE	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know	Not applicable
A	We **do not** dispose of edible portions of **any food** in our household	◯5	◯4	◯3	◯2	◯1	◯98	◯99
B	We **buy too much** food	◯5	◯4	◯3	◯2	◯1	◯98	◯99
C	We **cook too much** food	◯5	◯4	◯3	◯2	◯1	◯98	◯99
D	We do not keep food past its **'use by' or 'best before'** date	◯5	◯4	◯3	◯2	◯1	◯98	◯99
E	We do not **cook the meals** we planned	◯5	◯4	◯3	◯2	◯1	◯98	◯99
F	**Last minute change** of plans (family members don't turn up for meal etc.)	◯5	◯4	◯3	◯2	◯1	◯98	◯99
G	Household members do not **finish their meals**	◯5	◯4	◯3	◯2	◯1	◯98	◯99

H	There is not **enough space** to store the food in the fridge/freezer	◯5	◯4	◯3	◯2	◯1	◯98	◯99

SECTION B: ABILITY (SKILLS AND KNOWLEDGE)

[ASK ALL] - **Ability**

B1 In relation to **what you do with food** in your household, how much **do you agree** with the following?

Please choose one answer per row

	DO NOT ROTATE	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know	Not applicable
A	I am not sure **how to create** a **meal plan**	◯5	◯4	◯3	◯2	◯1	◯98	◯99
B	I find it difficult to estimate how **much food I need to buy**	◯5	◯4	◯3	◯2	◯1	◯98	◯99
C	When preparing a meal, I find it difficult to estimate **how much food** my **household** will **eat**	◯5	◯4	◯3	◯2	◯1	◯98	◯99
D	I find it **difficult to deviate from a recipe** (e.g. ingredients and quantities)	◯5	◯4	◯3	◯2	◯1	◯98	◯99
E	I am not sure what '**best before'** and **'use by'** dates mean	◯5	◯4	◯3	◯2	◯1	◯98	◯99
F	I do not know how to use **cooked leftovers**	◯5	◯4	◯3	◯2	◯1	◯98	◯99
G	I do not know how to use leftover **uncooked ingredients**	◯5	◯4	◯3	◯2	◯1	◯98	◯99
H	I do not know how **to store food** correctly to extend its life	◯5	◯4	◯3	◯2	◯1	◯98	◯99

I	I find it difficult to determine if food is **still safe to eat** (based on seeing, smelling, and/or tasting)	◯5	◯4	◯3	◯2	◯1	◯98	◯99

SECTION C: MOTIVATION (AWARENESS, ATTITUDE, SOCIAL NORMS AND LEVEL OF MOTIVATION)

[ASK ALL] - **Awareness of consequences**

C1 In relation to **disposing of food**, how much do you agree with the following?

Please choose one answer per row

	DO NOT ROTATE STATEMENTS	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know
	If I **reduce the amount** of food I dispose of, I am	**S/R**					
A	**Saving money** (from the cost of food not eaten)	◯5	◯4	◯3	◯2	◯1	◯99
B	**Saving the planet** (scarce resources water, energy etc. used up in producing food not eaten)	◯5	◯4	◯3	◯2	◯1	◯99
C	**Saving time** (from being more efficient in providing food)	◯5	◯4	◯3	◯2	◯1	◯99
D	Doing the **right thing** (providing benefits for others in society)	◯5	◯4	◯3	◯2	◯1	◯99
E	Demonstrating **good habits** (based on upbringing/culture/spiritual beliefs)	◯5	◯4	◯3	◯2	◯1	◯99
F	Setting a **good example** (for family and friends)	◯5	◯4	◯3	◯2	◯1	◯99

[ASK ALL] **– Attitude**

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know
A	I **feel guilty** when I dispose of food	◯5	◯4	◯3	◯2	◯1	◯99

B	I feel the **money saved** from **reducing amount** of food disposed of is **trivial**	◯5	◯4	◯3	◯2	◯1	◯99
C	I **feel foolish** when I dispose of food	◯5	◯4	◯3	◯2	◯1	◯99
D	I feel it is **possible to reduce amount** of food that I dispose of	◯5	◯4	◯3	◯2	◯1	◯98

C2 In relation to how you **feel about disposing of food**, how much do you agree with the following?

[ASK ALL] - **Social norms**

C3 In relation to **what most people who are important to you think of** disposing of food, how much do you agree with the following?

Please choose one answer per row

	DO NOT ROTATE	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know
A	Most **people important to me** try to minimise the amount of food **they dispose of**	◯5	◯4	◯3	◯2	◯1	◯99
B	Most **people important to me** expect me to minimise amount of food **I dispose of**	◯5	◯4	◯3	◯2	◯1	◯99

[ASK ALL] - **Level of motivation**

C4: How **motivated** are you to **reduce the amount of food that is not eaten** and hence disposed of in your household?

Please choose only one of the following:

REVERSE LIST FOR HALF OF RESPONDENTS 1-5. DO NOT RANDOMISE ORDER	**S/R**
I am already doing this **most** of the time	◯1

I do this, but just **some** of the time	◯ 2
I do not do this, but have decided to **start** doing it	◯ 3
I do not do this, but I am **thinking** about it	◯ 4
I do not do this, and have **no plans** to start doing so	◯ 5

SECTION D: COMPETING GOALS

[ASK ALL] - **Goals**

D1 In relation to **disposing of food not eaten**, how much do you agree with the following?

Please choose one answer per row

	DO NOT ROTATE	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know	Not applicable
A	We like to eat **tasty food**	◯ 5	◯ 4	◯ 3	◯ 2	◯ 1	◯ 98	◯ 99
B	We like to eat the **freshest** food possible	◯ 5	◯ 4	◯ 3	◯ 2	◯ 1	◯ 98	◯ 99
C	We like to eat **healthy** food	◯ 5	◯ 4	◯ 3	◯ 2	◯ 1	◯ 98	◯ 99
D	We like to eat a **variety** of foods	◯ 5	◯ 4	◯ 3	◯ 2	◯ 1	◯ 98	◯ 99
E	We **do not** like to eat **leftovers**	◯ 5	◯ 4	◯ 3	◯ 2	◯ 1	◯ 98	◯ 99

SECTION E: OPPORTUNITY

[ASK ALL] - **Opportunity**

E1 In relation to **management of food** in your household, how much do you agree with the following?

Please choose one answer per row

	DO NOT ROTATE	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't Know
A	I am **too busy** to **plan meals**	◯5	◯4	◯3	◯2	◯1	◯99
B	I am **too busy** to **cook** the meals I planned	◯5	◯4	◯3	◯2	◯1	◯99
C	I am **unable** to cook meals I planned due to **changes** in activities (work schedules, social engagements etc.)	◯5	◯4	◯3	◯2	◯1	◯99
D	I find it **difficult** to get to shops that sell the food I **like to cook**	◯5	◯4	◯3	◯2	◯1	◯99
E	I find it **difficult** to **buy the amount** of food **I like to cook** (package sizes etc.)	◯5	◯4	◯3	◯2	◯1	◯99
F	I do not **have enough space** in my **fridge** and **freezer** to store my food	◯5	◯4	◯3	◯2	◯1	◯99
G	I do not **have enough containers** to store my food	◯5	◯4	◯3	◯2	◯1	◯99

SECTION F: CHANGING BEHAVIOURS

[ASK ALL] - **Behaviours**

F1 How likely are you to change your behaviours to reduce the amount of food not eaten and hence disposed of?

Please choose one answer per row

		Highly likely to change	Likely to change	Neutral	Unlikely to change	Highly unlikely to change	Don't Know
A	Changing food **planning behaviours**	◯5	◯4	◯3	◯2	◯1	◯99
B	Changing food **shopping** behaviours	◯5	◯4	◯3	◯2	◯1	◯99
C	Changing food **storing** behaviours	◯5	◯4	◯3	◯2	◯1	◯99
D	Changing food **preparation** behaviours	◯5	◯4	◯3	◯2	◯1	◯99

E	Changing food **disposal** behaviours	◯5	◯4	◯3	◯2	◯1	◯99

SECTION G: SPENDING ON GROCERIES

[ASK ALL] - **Spending**

G 1 How much does **your household** spend on **food eaten at home** (food from supermarkets, meals delivered to home etc.)?

Insert number	$..... per week

SECTION H: FOOD DISPOSED OF

[ASK ALL] - **Disposal**

H1 In the past **7 days,** how much of the following food types was **disposed of** in your household (by you and other household members)?

Include all food and liquids:

- put in the rubbish bin
- put in the compost/worm farm
- fed to pets
- tipped down the sink

Please choose one answer in each row

	Food Category	**Some examples of this category**	**Unit of measurement** **1 cup= 250ml or 250g**	**Type in number of cups that disposed of in the last 7 days**	***Disposal route for majority of food in the category (pick from drop down menu shown below)**
1	**Food prepared at home**	Includes meals and components prepared at home (spaghetti Bolognese, cooked rice, cooked vegetables, salads etc.)	one cup		
2	**Takeaway and home delivery meals**	Includes takeaway meals consumed at home and home deliveries eaten at home.	one cup		
3	**Fresh vegetables**	Includes salads, fresh herbs (lettuce, avocado, tomato etc.)	one cup		

4	**Frozen/canned/dried vegetables**	Includes frozen potatoes, canned beetroot, dried mushrooms etc.	one cup		
5	**Fresh fruits**	Includes fresh bananas, oranges, berries, apples etc.	one cup		
6	**Frozen/canned/dried fruit**	Includes frozen blue berries, tinned peaches, dried sultanas etc.	one cup		
7	**Dairy**	Includes milk, yogurt, cheese, butter etc.	one cup		
8	**Meat and seafood (uncooked)**	Includes chicken, beef, pork, fish, prawns, sausages, processed meats etc. (Cooked meat included in Food prepared at home section).	one cup		
9	**Staples (uncooked)**	Includes uncooked rice, pasta, cereals, oats, noodles, lentils etc. (Cooked staples included in Food prepared at home section).	one cup		
10	**Bread**	Includes whole loaves and sliced bread, bread rolls etc.	one slice		
11	**Bakery**	Includes cakes, desserts, confectionaries, chips, biscuits, nuts, pastries, pies, muffins, donuts etc.	one cup		
12	**Drink**	Includes tea, coffee, juices, soft drinks etc.	one cup		
13	**Other**	Includes sauces, dried herbs, spices, spreads, oils etc.	one cup		
15	**Inedible parts of foods**	Includes skins, bones, shells, cores, tea bags, coffee grounds etc.	one cup		

I. Demographics

I1 Please indicate your gender:
Please choose one of the following:

DO NOT ROTATE	**S/R**
Male	◯1
Female	◯2
I identify as [OPEN ENDED BOX IF CODE 3]	◯3

I2 How many **people in each age group** usually **live at your household**? (Please include them if they live there half the time or more).

Please insert number of people in each row

[A NUMBER IN AT LEAST ONE FIELD MUST BE 1 OR GREATER. NOT ALL FIELDS MANDATORY]

	Insert number **(number of people in your household representing each age group)**
0-4 year olds	
5-9 year olds	
10-14 year olds	
15-19 year olds	
20-24 year olds	
25-34 year olds	
35-44 year olds	
45-54 year olds	
55-64 year olds	
65-74 year olds	
75 years old or older	

I3 Which of the following best describes your household?

Please choose only one of the following:

Household of unrelated people	◯ 1
Couple living together with no children	◯ 2
Couple with children (<17 years old)	◯ 3
Couple with adult children (>18 years old)	◯ 4
Single parent with children (<17 years old)	◯ 5
Single parent with adult children (>18 years old)	◯ 6
Couple living without children (child/children no longer reside in same household)	◯ 7
Living alone	◯ 8
Prefer not to say	◯ 99

I4 Which of the following best describes your **household income** (before tax)?

(This refers to the total income from all household occupants, and includes income from wages and salaries, government benefits, pensions, allowances and any other income you usually receive. It is before deductions for tax and superannuation contributions)

Please choose only one of the following:

Negative income	◯ 1
No income	◯ 2
$1-$149 per week ($1-$7,799 per year)	◯ 3
$150-$299 per week ($7,800-$15,599 per year)	◯ 4
$300-$399 per week ($15,600-$20,799 per year)	◯ 5
$400-$499 per week ($20,800-$25,999 per year)	◯ 6
$500-$649 per week ($26,000-$33,799 per year)	◯ 7
$650-$799 per week ($33,800-$41,599 per year)	◯ 8
$800-$999 per week ($41,600-$51,999 per year)	◯ 9
$1,000-$1,199 ($52,000-62,399 per year)	◯ 10
$1,200-$1,399 ($62,400-$72,799 per year)	◯ 11
$1,400-$1,549 ($72,800-80,599 per year)	◯ 12
$1,550-$1,699 ($80,600-$88,399 per year)	◯ 13

$1,700–$1,799 ($88,400-$93,599 per year)	◯ 14
$1,800–$1,899 ($93,600-$98,799 per year)	◯ 15
$1,900–$1,999 ($98,800-$103,999 per year)	◯ 16
$2,000–$2,199 ($104,000-$114,399 per year)	◯ 17
$2,200–$2,399 ($114,400-$124,799 per year)	◯ 18
$2,400–$2,599 ($124,800-$135,199 per year)	◯ 19
$2,600–$2,799 ($135,200-$145,599 per year)	◯ 20
$2,800–2,999 ($145,600-$155,999 per year)	◯ 21
$3,000–3,499 ($156,000-$181,999 per year)	◯ 22
$3,500–3,999 ($182,000-$207,999 per year)	◯ 23
$4,000–4,499 ($208,000-$233,999 per year)	◯ 24
$4,500–4,999 ($234,000-$259,999 per year)	◯ 25
$5,000–5,999 ($260,000-$311,999 per year)	◯ 26
$6,000 or more ($312,000+ per year)	◯ 27
Prefer not to say	◯ 99

Thank you very much for your time today.

Do you have any comments in relation to this survey?

Please write your answer here:

Please click 'submit' to send your responses to us.

Thanks for agreeing to participate in our research.

9.2. Electronic-diary

Add text to explain what this is…

	Food Category	Some examples of this category	Products	Unit of measurement 1 cup= 250ml or 250g	Type in number of cups that disposed of in the last 7 days	*Disposal route for majority of food in the category (pick from the drop down menu)
1	**Food prepared at home**	Includes dishes prepared at home, pre-prepared food bought at supermarkets as well as ingredients such as cooked pasta, rice etc.	1.1 Pasta/spaghetti (cooked) 1.2 Rice (cooked) 1.3 Noodles (cooked) 1.4 Beef (cooked) 1.5 Chicken (cooked) 1.6 Seafood (cooked) 1.7 Eggs (cooked) 1.8 Potato (cooked) 1.9 other vegetables (cooked) 1.10 Pizza - homemade/ pre-prepared/ supermarket bought 1.11 Burgers/sandwiches prepared at home 1.12 Soup -homemade/ supermarket bought	one cup		

			1.13 Other home cooked food			
2	**Takeaway and home delivery meals**	Includes takeaway meals consumed at home and home deliveries eaten at home.	2.1 Pasta/spaghetti - take away 2.2 Rice - take away 2.3 Noodles - take away 2.4 Curry (meat/vegetables) - take away 2.5 Pizza – takeaway 2.6 Burgers/sandwiches 2.7 Other take away/ home delivery meals	one cup/ one cup of chopped		
3	**Fresh vegetables**	Includes salads, fresh herbs and some items that are seeded but considered as vegetables such as avocado and tomato	3.1 Tomato - fresh 3.2 Salad - fresh 3.3 Potato - fresh 3.4 Mushroom - fresh 3.5 Carrot - fresh 3.6 Celery - fresh 3.7 Beans - fresh 3.8 Avocado - fresh 3.9 Salad leaves - fresh 3.10 Other vegetables - fresh	One cup of chopped		
4	**Frozen/canned/dried vegetables**	Includes frozen potatoes, canned beetroots, dried mushrooms etc.	4.1 Frozen vegetables 4.2 Canned vegetables	one cup		

			4.3 Dried vegetables			
5	**Fresh fruits**	Includes fresh bananas, oranges, berries, apples etc.	5.1 Banana - raw, fresh 5.2 Stone fruits - fresh 5.3 Apple - fresh 5.4 Mango - fresh 5.5 Strawberry - fresh 5.6 other berries - fresh 5.7 Orange/mandarin - fresh 5.8 Pear - fresh 5.9 Grape - fresh 5.10 Other fruits - fresh	one cup of chopped		
6	**Frozen/canned/dried fruit**	Includes frozen blue berries, tinned peaches, dried sultanas etc.	6.1 Frozen fruits 6.2 Canned fruits 6.3 Dried fruits	one cup of chopped		
7	**Dairy**	Includes milk, yogurt, cheese, butter etc.	7.1 Milk dairy 7.2 Non-dairy milk (soy, almond, cashew, oat, hemp) 7.3 Yogurt 7.4 Cheese 7.5 Butter 7.6 Other dairy and non-dairy foods	one cup		

8	**Meat and seafood (uncooked)**	Includes chicken, beef, pork, fish, prawns, sausages, processed meats etc.	8.1 Chicken - raw 8.2 Beef - raw 8.3 Pork- raw 8.4 Lamb - raw 8.5 Seafood - raw 8.6 Processed meats - raw 8.7 Other meats	one cup of chopped		
9	**Staples (uncooked)**	Includes raw rice, pasta, cereals, oats, noodles, lentils etc	9.1 Pasta - uncooked 9.2 Noodles - uncooked 9.3 Rice - uncooked 9.4 Breakfast cereals - uncooked 9.5 Other dried staples including flour	one cup		
10	**Bread**	Includes whole loaves and sliced bread, bread rolls etc.	10.1 Whole loaves 10.2 Sliced bread 10.3 Bread rolls 10.4 Flat breads/wraps	one cup of chopped		
11	**Bakery and Snacks**	Includes cakes, desserts/confectionaries chips, biscuits, nuts, pastries, pies, muffins, donuts etc.	11.1 Nuts 11.2 Desserts/confectionaries 11.3 Biscuits 11.4 Pastries, pies	One cup of chopped		

			11.5 Other bakery and snack items (except bread)			
12	**Drink**	Includes tea, coffee, juices, soft drinks etc.	12.1 Tea 12.2 Coffee 12.3 Juices 12.4 Soft drinks 12.5 other drinks (except water)	one cup		
13	**Other**	Include condiments, dried herbs, spices, spreads, oils etc	13.1 Condiments 13.2 Dried herbs 13.3 Spices 13.4 Spreads 13.5 Oils	One cup		
14	**Unavoidable food waste**	Including anything inedible at time of purchase such as skins, bones, shells, cores, tea bags, coffee grounds etc.	14.1 Skins/outer leaves 14.2 Bones 14.3 Shells 14.4 Cores 14.5 Other unavoidable	one cup		

Note for comparison of outputs from instruments compared to results published in 2021.

*Cooked meat was previously under the meat and sea food category.

9.3. Bin audit

Screening questions

Which of the following does your household have?

Please choose all that apply

DO NOT ROTATE	**M/R**	
Shared General Waste bin (Dark Green or Black body with **Red lid)** – other households in the building/apartment complex use the same rubbish bin as you	¨1	THANK AND CLOSE
Own General Waste bin (Dark Green or Black body with **Red lid)** – You have your own rubbish bin just for use by your household	¨2	CONTINUE **[ALL MUST CODE 2 or 4 TO CONTINUE]**
Food scraps/waste bin – (trialled in select suburbs) Usually a Dark Green or Black body with **Burgundy lid**	¨3	THANK AND CLOSE
Green Waste/Organics bin – Dark Green or Black body with **Green lid**	¨4	CONTINUE **[ALL MUST CODE 2 or 4 TO CONTINUE]**
Compost bin (a place for food scraps and garden waste)	¨5	CONTINUE
Worm farm	¨6	CONTINUE
Dog	¨7	CONTINUE
Cat	¨8	CONTINUE
Chickens/poultry	¨9	CONTINUE

Other animals	¨10	CONTINUE

[ONLY ASK THOSE WHO QUALIFY FOR BIN AUDIT IE CODE 1 AT S3 AND ONLY CODE 2 AT S4]

S5a How frequently do you put out your general waste bin on the curb/street to get emptied?

I/my household put out our waste bin on the curb/street **once a week** to be emptied	◯1	CONTINUE
I/my household put out our waste bin on the curb/street **once a fortnight** to be emptied	◯2	CONTINUE
I/my household put out our waste bin on the curb/street **once a month** to be emptied	◯3	CONTINUE
I/my household don't put out our waste bin on the curb/street, we empty our rubbish into a communal bin	◯4	THANK AND CLOSE

[ONLY ASK THOSE WHO QUALIFY FOR BIN AUDIT IE CODE 1 AT S3 AND ONLY CODE 2 AT S4]

S5b On which morning of the week does your general waste bin get collected?

Monday mornings	◯1	CONTINUE
Tuesday mornings	◯2	CONTINUE
Wednesday mornings	◯3	CONTINUE
Thursday mornings	◯4	CONTINUE
Friday mornings	◯5	CONTINUE
Saturday mornings	◯6	CONTINUE

Sunday mornings	○7	CONTINUE
I don't know	¨98	THANK AND CLOSE
N/A - my household does not have its own bin	¨99	THANK AND CLOSE

[ONLY ASK THOSE WHO QUALIFY FOR BIN AUDIT IE CODE 1 AT S2 AND ONLY CODE 2 AT S2]

S6 Thinking of your general waste bin, how easy is it to empty?

Our bin is easily accessible from the street, and the truck driver does not need to get out of his truck to access it	○1	CONTINUE
Our bin is generally accessible but the waste management workers sometimes need to get off the truck to move it somewhere they can empty it	○2	CONTINUE
The garbage truck cannot reach our bin from the street, the waste management workers need to search for the bin to empty it	○3	THANK AND CLOSE
Our bin remains inside the property and is emptied separately to the regular garbage collection times	○4	THANK AND CLOSE

ONCE CODES 1 AND 2 SELECTED, SHOW I3]

Thank you. Please provide your contact details below to register your interest.

Please be assured all your personal information is treated in the strictest of confidence and we adhere to the Market and Social Research Privacy Principles. You can read Instinct and Reason's privacy policy **here.**

We will contact you again in the near future once the research starts.

[ALL FIELDS ARE MANDATORY]

First Name	
Surname	
Phone number	
Email address	

Residential address

Note: we require your residential address to ensure we include a good spread of people across Australia for the bin audit.

Unit number (leave blank if not applicable)	
Street number	
Street name	
Suburb	
State	
Postcode	

Table 16: Bin audit categories

Bin audit (14 categories)	
1. Meals	Includes all prepared food such as cooked vegetables, meats, pasta and rice etc.
2. Fresh vegetables	Includes salads, fresh herbs and some items that are seeded but considered as vegetables such as avocado and tomato
3. Frozen/canned/dried vegetables	Includes frozen potatoes, canned beetroots, dried mushrooms etc.

4. Fresh fruit	Includes fresh bananas, oranges, berries, apples etc.
5. Frozen/canned/dried fruit	Includes frozen blue berries, tinned peaches, dried sultanas etc.
6. Dairy	Includes milk, yogurt, cheese, butter etc.
7. Meat and seafood (uncooked)	Includes uncooked chicken, beef, pork, fish, prawns, sausages, processed meats etc.
8. Staples (uncooked)	Includes uncooked rice, pasta, cereals, oats, noodles, lentils etc
9. Bread	Includes whole loaves and sliced bread, bread rolls etc.
9. Bakery and snacks	Includes cakes, desserts/confectionaries chips, biscuits, nuts, pastries, pies, muffins, donuts etc.
11. Drinks	Includes tea, coffee, juices, soft drinks etc.
12. Other	(condiments, dried herbs, spices, spreads, oils etc)
13. Inedible food waste	Unavoidable waste including anything inedible such as skins, bones, shells, cores, tea bags, coffee grounds etc.
14. Cannot be identified	Food decomposed and cannot be identified separately within a category

Romani, S., S. Grappi, R. P. Bagozzi and A. M. Barone (2018). "Domestic food practices: A study of food management behaviors and the role of food preparation planning in reducing waste." Appetite **121**: 215-227.

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