



JRC TECHNICAL REPORT

Scoping consumer food waste: an evaluation framework of prevention interventions

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2023



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JRC128763

EUR 31582 EN

PDF ISBN 978-92-68-05350-8 ISSN 1831-9424 [doi:10.2760/3128](https://doi.org/10.2760/3128) KJ-NA-31-582-EN-N

Luxembourg: Publications Office of the European Union, 2023

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How to cite this report: Garcia Herrero, L., Casonato, C., Caldeira, C., De Laurentiis, V., Bruns, H. and Sala, S., *Scoping consumer food waste: an evaluation framework of prevention interventions*, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/3128, JRC128763.

Contents

Abstract.....	1
Acknowledgements.....	2
Executive summary.....	3
1 Introduction	5
2 State of the art.....	9
2.1 Assessment of food waste prevention actions: consumers' focus.....	9
2.1.1 Consumer behaviour change results from the assessed interventions.....	9
2.1.2 Conclusions and further research	10
2.2 Further findings from 2019 and onwards on food waste intervention evaluation	10
2.3 Food waste drivers and levers for behavioural change.....	11
2.3.1 Food waste literature evolution	11
2.3.2 Conceptualizing consumer food waste with the Motivation-Opportunities-Abilities framework.....	12
2.3.3 Drivers and levers for consumer food waste	12
2.4 Food waste drivers and levers for behavioural change.....	14
3 Scope of the European Consumer Food Waste Forum.....	15
4 Framework for the evaluation of consumer food waste reduction interventions.....	17
4.1 Types of frameworks identified in the review and proposal of a new one.....	17
4.2 Quality of the intervention design	19
4.3 Effectiveness.....	20
4.4 Efficiency	20
4.5 Perceived wider systemic effects of the intervention	21
4.6 Sustainability over the time	21
4.7 Transferability and scalability	21
4.8 Data collection protocol	24
5 Tools, best practices, and recommendations.....	37
5.1 Update of the food waste prevention calculator	37
5.2 Target audience segmentation: a brief outlook	40
5.3 Food waste quantification techniques and available protocols	49
5.3.1 Measurement methodologies	50
6 Conclusions.....	56
References.....	57
List of abbreviations and definitions.....	62
List of boxes.....	63
List of figures.....	64
List of tables	65
Annexes.....	66
Annex 1. Glossary	66
Annex 2. Data collection template	69
Annex 3. Example of application	76

Abstract

Food waste is a global concern already identified to be addressed in the Sustainable Development Goals (12.3) and the EU policy agenda under the Circular Economy Action Plan and the Green Deal within the Farm to Fork Strategy. The EU has committed to halving food waste at the retail and consumer level following SDG 12.3, establishing legally binding reduction targets and enabling their reach through the setting of baseline measurement and uniform monitoring. Across the Member States, most food waste occurs at the consumer level. Therefore, reducing consumer food waste is critical for achieving future EU-level targets for food waste reduction. Consumer food waste (both in- and out-of-home) - whilst influenced by the food supply chain and food environment - is essentially a behavioural issue. The behavioural factors underlying consumers' decisions to discard food need to be uncovered, and consumer-focused interventions have to be adequately designed to deliver on the ambitious target reduction. To address the existing research gaps, the Directorate-General for Health and Food Safety (DG SANTE) and the Joint Research Centre (JRC) established a multi-disciplinary forum of researchers and practitioners in the area of consumer food waste prevention under the pilot project called the European Consumer Food Waste Forum (ECFWF). The ECFWF will issue research- and evidence-based recommendations and develop tools to help reduce consumer food waste, aiming to produce a compendium of best practices and recommendations to facilitate the uptake of effective interventions. To this end, there was the need to 1) define the scope, i.e., the type of interventions, tools, best practices and recommendations to be explored, and 2) to develop an evaluation framework specifically tailored for consumer interventions. This has been done by 1) conducting several literature reviews on the state of the art of intervention evaluation and available frameworks, and on the main food drivers and levers of consumer food waste, 2) organising a virtual workshop, meetings and gathering written feedback on the discussed topics from ECFWF members.

This report outlines the scope of the ECFWF and the evaluation framework for consumer food waste prevention interventions. The latter is complemented with a data protocol for the collection of information on interventions and some selected tools, best practices, and recommendations agreed under the scope of the ECFWF.

Acknowledgements

This report is a deliverable of the Administrative Arrangement between DG Health and Food Safety (DG SANTE) Contract n° /2021/ SI2.851759 and the Joint Research Centre (JRC) n° 36041 focusing on “Provision of technical and scientific support to DG SANTE in relation to Pilot project – European Consumer Food Waste Forum”.

The authors of this report would like to thank:

- Anne-Laure Gassin (EC - SANTE) and Cristina Lisetchi (EC – SANTE) for the guide to define the scope, elaborate the framework, and for the provision of comments.
- Zsuzsa Turoczy, Maria Teresa Borzacchiello and Marios Avraamides for the support in the workshop and meetings organisation.
- The members of the European Consumer Food Waste Forum for their support in providing further inputs to be included in the study, as well as for reviewing the first draft of this document, meaning (in alphabetic order): Bent Egberg Mikkelsen, Christophe Diercxsens, Gang Liu, Gudrun Obersteiner, Gulbanu Kaptan, Gyula Kasza, Iva Miranda Pires, Jenni Vainioranta, Jose Maria Gil, Kohei Watanabe, Matteo Vittuari, Richard Swannell, Stephanie Wunder, Thomas Candéal, and Ylva Haglund. A particular acknowledgment to Erica van Herpen, leader of the task, for her support in the development of this report and the associated activities.

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Executive summary

Food waste reduction is a policy priority of the European Commission. In line with SDG 12.3, the Commission has committed to reaching a 50 % reduction of food waste at consumer and retail level and will propose legislation to ensure that the EU's progress towards this target. Consumption is estimated as the most wasteful stage in the food supply chain, successfully targeting consumers might deliver substantial reduction in food waste quantities. To aid the decision-making process with a strong evidence base, the European Parliament has commissioned a pilot project focussing specifically on consumer food waste called the European Consumer Food Waste Forum (ECFWF). This pilot project includes a multi-disciplinary forum of experts - researchers and practitioners - in the area of consumer food waste prevention who meet to provide evidence-based tools, best practices and recommendations. The ECFWF was established in June 2021 and it will run for two years thanks to the coordination of the Directorate-General for Health and Food Safety (DG SANTE) and the Joint Research Centre (JRC). The pilot project works in close collaboration with the EU Platform on Food Losses and Food Waste (FLW), established to support all actors in defining measures needed to prevent food waste; sharing best practices; and evaluating progress made over time. The Platform was established in 2016 and in 2022 was re-established for a second mandate, until 2026. The Platform is articulated in different sub-groups, of which the sub-group on consumer food waste prevention will cooperate closely with the ECFWF and will be consulted during the project, especially to help identify interventions to be assessed by the Forum.

In order to identify the most effective and efficient consumer food waste prevention interventions to be recommended by the ECFWF, this report reflects on the specific task of **defining the scope of the ECFWF**, i.e., the type of interventions, tools, best practices and recommendations to be explored, and a **framework to evaluate** these interventions.

The task was completed by following a specific methodology: literature reviews and iterative feedback within the Forum:

- Literature reviews: Several literature reviews were conducted to support the scope's definition and to identify different evaluation frameworks, uncovering their relevant elements and application to tailor last evaluation framework published. The work of Caldeira et al. (2019a) served as the base to elaborate this evaluation framework, as it is one of the few examples of comprehensive evaluations of food waste prevention interventions along the whole supply chain.
- Iterative feedback: These literature reviews stimulated the discussion with the experts during the two virtual events held under this activity – one workshop and one meeting. Written feedback was also obtained from the experts through different surveys circulated before the workshop or through feedback tables to the summary of the workshop and the draft of the present deliverable.

The interventions to be covered under the ECFWF were jointly defined by the experts, DG SANTE and JRC, and will focus on:

1. Nudging strategies and promoting a change of consumer's choice architecture. Within nudges, interventions leveraging the power of social influence should be prioritised, as they might be particularly effective in changing behaviour;
2. Education and training – particularly for the younger generations because they have been identified as a good starting point to shape positive consumer behaviours (as adults, but also within their families as children) and because food waste prevention can be integrated in other food-related topics such as food literacy, nutrition, sustainable diets etc.; and
3. Interventions focusing on awareness-raising and dissemination of information are also to be evaluated, as data reported on their performance could be connected with behavioural changes.

The **tools, best practices and recommendations** that will be proposed by ECFWF are:

1. Recommendations to improve monitoring: information or knowledge sources on how to monitor ongoing interventions.
2. Target audience segmentation for interventions.
3. A review of food waste quantification techniques for practitioners.
4. An updated version of the food waste prevention evaluation calculator.
5. Guidance on experimental design to design and evaluate interventions.

These were detected and selected due to their multi-dimensionality and ease of use in terms of: accessibility of language, flexibility to adapt to different interventions, and intuitiveness. This report provides some insights for

the first four **tools, best practices and recommendations** proposed by ECFWF, while the last one will be covered in a separated report.

Taking into account the scope of the ECFWF, the framework for the evaluation of consumer food waste interventions was developed and tailored to capture those interventions proving a behavioural change toward food waste reduction. Therefore, inputs to measure these changes have been provided. The criteria defined in the framework are briefly described below:

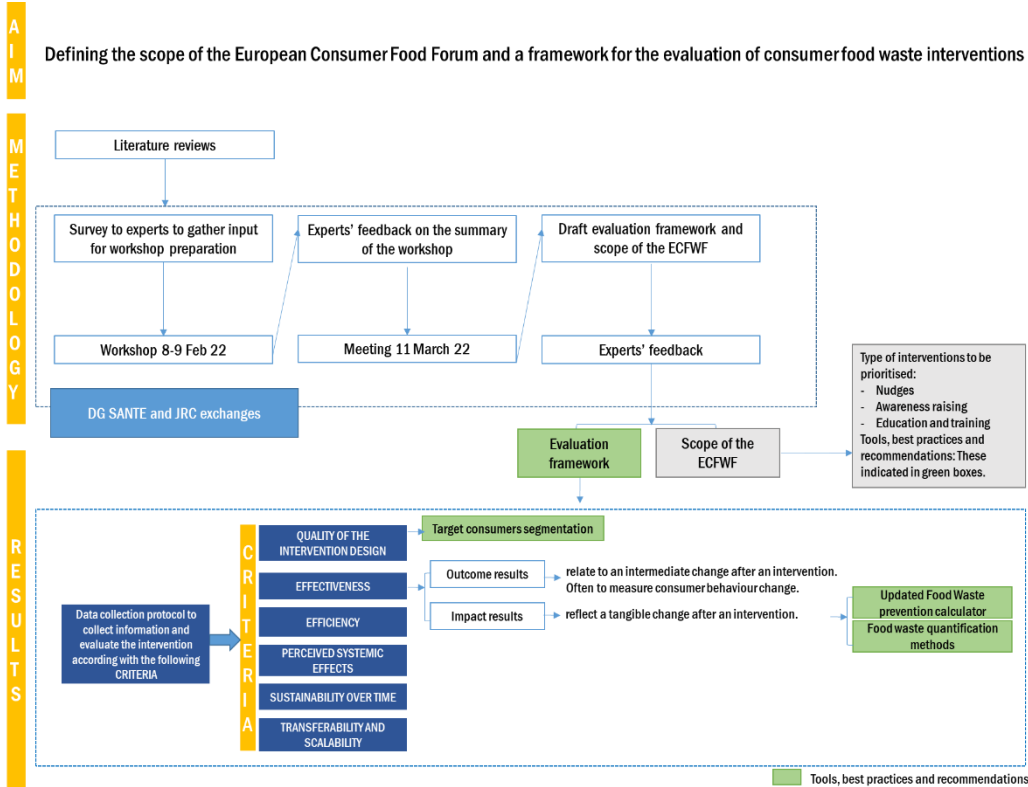
- **Quality of the intervention design:** The intervention design is well defined, planned, and implemented. The identified problem and the response are tailored to the target audience including measurable, reliable, and sensitive objectives.
- **Effectiveness:** food waste reduced, or consumer behavioural change was reported according to the target set. The targets established, referred to reach impact or outcome results, are reached.
- **Efficiency:** the intervention reached the target with the least resources (e.g. time, cost).
- **Perceived systemic effects:** the intervention brought synergies to speed up the target set (or instead, trade-off to be considered). It also allowed cooperation between different sectors of society.
- **Sustainability over time:** intervention’s longevity and its potential to maintain its effects over time.
- **Transferability and scalability:** intervention can be/has been transferred to a different context or up scaled. This identifies how the intervention incorporates multi-level aspects and might help identify interventions working well in different contexts.

Whenever possible, all criteria should be reported, while if limited resources are available to evaluate the interventions, the user should prioritise the compilation of the first four criteria. Data on impacts and intermediate outcomes are critical for an exhaustive evaluation. When impact results are not evaluated due to lack of information or resources, outcome indicators are envisaged as a proxy for effectiveness of the intervention.

A data collection protocol was designed to accompany the evaluation framework to facilitate data gathering. Additionally, an example on its compilation has been included to support the user.

The overall aim, method and results of this task are presented in Figure 1.

Figure 1. Overview of the aim, method and results presented in this report.



Source: Own elaboration.

1 Introduction

A shift towards sustainable food systems is urgently needed to feed a rising global population in a pressing and restrictive climate change context (Willett et al. 2019). A key issue of this transition is food waste. In the EU, households generate more than half of the total food waste (53%) in the EU with 69% of food waste arising at household, food service and retail, every second day some 32.6 million people cannot afford a quality meal in the EU (Eurostat, 2022). This creates a significant environmental and climate impact putting an unnecessary burden on limited natural resources, such as land and water (FAO, 2019). Globally, if food waste were a country, it would be the third-largest greenhouse gas emitter after China and the United States (FAO, 2015). Food waste reduction is thus essential for establishing sustainable food systems.

The European Commission is working to tackle food waste with different policy approaches. The Circular Economy Action Plan, adopted in 2015 puts forward food waste prevention and the need to adopt a more sustainable production and consumption model as priority areas. The Farm to Fork Strategy (European Commission, 2020), a key component of the European Green Deal, proposes actions to help consumers choose healthy and sustainable diets and reduce food waste. Moreover, the Farm to Fork strategy states that: *“using a new methodology for measuring food waste and the data expected from MS in 2022, the Commission will set a baseline and propose legally binding targets to reduce food waste across the EU”* in order to ensure that MS efforts against food waste are informed by a solid evidence base and support sharing of innovation and best practices. The reach of this target is enabled by a legislative framework, including the amended Waste Framework Directive (2018/851/EC) and the Commission Delegated Decision (EU) 2019/1597. The former establishes clear definition of food waste, while the latter proposes common methodology and minimum quality requirements for the uniform measurement of food waste (European Commission, 2019). It is also indicated that Member States should take measures to promote prevention and reduction of food waste in line with the 2030 Agenda for Sustainable Development, and in particular, its target of halving per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses (SDG 12.3). The most recent figures for food waste at consumption stage estimate an average of 79 kg/capita/year in high-income countries (UNEP, 2021), and 70 kg/capita/year in the EU (Eurostat, 2022) by far higher than any other step in the supply chain. Targeting this stage of the supply chain is therefore a priority (Sanchez-Lopez et al., 2020).

In 2019, the JRC assessed the food waste prevention actions taking place at the time in the EU (Caldeira et al. 2019a). The results of that research informed the development of the "Recommendations for Action in Food Waste Prevention" by the EU Platform on Food Losses and Food Waste (FLW)¹ which contains a list of recommendations for action at each stage of the food supply chain, including at consumer level. One of these recommendations, "Improve action design, monitoring, evaluation and knowledge-sharing regarding food waste prevention interventions", calls for creating a network of researchers and practitioners to champion evaluation; obtaining sufficient funding, further developing guidance, facilitating the use of evaluation findings, and conducting a meta-analysis of findings for the development and use of a wider range of methods to better understand consumer behaviour regarding food waste and effectively design solutions."

In order to provide evidence-based recommendations to reduce food waste at consumer level, and to address the recommendations highlighted above, the Directorate-General for Health and Food Safety (DG SANTE) in collaboration with the Joint Research Centre (JRC) is running a 2-year pilot project (June 2021- July 2023) called the **European Consumer Food Waste Forum** (ECFWF in this report).

Under this pilot project a network of experts was established in October 2021 - sixteen researchers and practitioners – with wide expertise in the consumer food waste prevention area. Since then, they are working together to find solutions and to develop a variety of evidence-based practical solutions to reduce food waste at the consumer level, including household and food services.

This aim of the ECFWF is articulated in different objectives:

¹ The EU Platform on Food Losses and Food Waste (FLW) was established in 2016, bringing together EU institutions, experts from the EU countries, international organisations and relevant stakeholders selected through an open call for applications. The Platform aims to support all actors in: defining measures needed to prevent food waste; sharing best practice; and evaluating progress made over time. https://ec.europa.eu/food/safety/food-waste/eu-actions-against-food-waste/eu-platform-food-losses-and-food-waste_en

- Review of evidence on drivers of consumer food waste and levers for behavioural change to inform the identification of effective and efficient interventions;
- Research and data collection on interventions to prevent and reduce consumer food waste, in particular in EU Member States;
- Evaluation of the identified interventions based on their feasibility, reach and effectiveness;
- Definition of research protocols and recommendations for effective interventions and further research, to be tailored and carried out at national and regional levels;
- Development of a compendium of multi-dimensional, multi-level, evidence-based set of tools that can be applied by the EU Member States, regional and local administrations.

Building on the first objective, which provided a review of evidence on drivers of consumer food waste and levers² for behavioural change, this report presents:

- 1) The **scope of the ECFWF**, i.e., type of interventions to be identified and evaluated, as well as the types of tools, best practices, and recommendations that will be developed. This scope was agreed with the experts in the context of an online workshop and an intermediate meeting to consolidate experts' opinions.
- 2) **A framework for the evaluation of consumer food waste prevention interventions**. It brings an updated evaluation framework focused on consumer food waste prevention interventions, building on the abovementioned assessment conducted by Caldeira et al. (2019a) and different literature reviews and experts' opinions. This framework was designed together with a data collection protocol and an example, to help the user in gathering the data supporting the evaluation.
- 3) **Tools, best practices, and recommendations selected and defined together within the scope**. They aim to support the evaluation framework, while they could also be used by the practitioners independently.

This report fills the gap existing in literature, as evidenced by literature reviews and experts' feedback conducted under this work. Several authors have already acknowledged the lack of a systemic evaluation of food waste prevention interventions (Reynolds et al., 2019, Wunder et al., 2019), while also some efforts have attempted to fill this gap (Caldeira et al., 2019a, Qusted, 2019). However, a tailored approach dealing with the supply chain segment where most of the food waste occurs in the EU was missing. To contribute to this research gap, the JRC and DG SANTE, in collaboration with the experts of the ECFWF have worked together in the following activities:

1) Literature reviews and summaries of main documents:

- a summary from the starting point report, Caldeira et al. (2019a), particularly when targeting consumer food waste interventions.
- a literature review to identify which evaluation frameworks were already published targeting consumer food waste prevention initiatives and which recommendations or adjustments these proposed when applying them.
- a summary of the literature review on drivers and levers – developed within the ECFWF in a previous task as drivers and levers are considered the starting point when designing an intervention.
- a literature review to identify different interventions' classifications targeting consumer food waste prevention, detect the main characteristics of these interventions, and inspire the experts when defining the scope of the Forum.

² **Drivers:** factors that affect behaviour. These can be more internal, i.e., awareness, attitudes, cognitions, emotions, or more external, i.e., behaviour of others, tools, technologies, etc. In the context of food waste, drivers are these factors leading to food waste generation, for example, the perception of consequences of food waste for climate change. **Levers:** areas of opportunity for action. Those aspects of behavioural drivers that can be leveraged for systematically influencing food waste behaviour, by means of interventions (own definition).

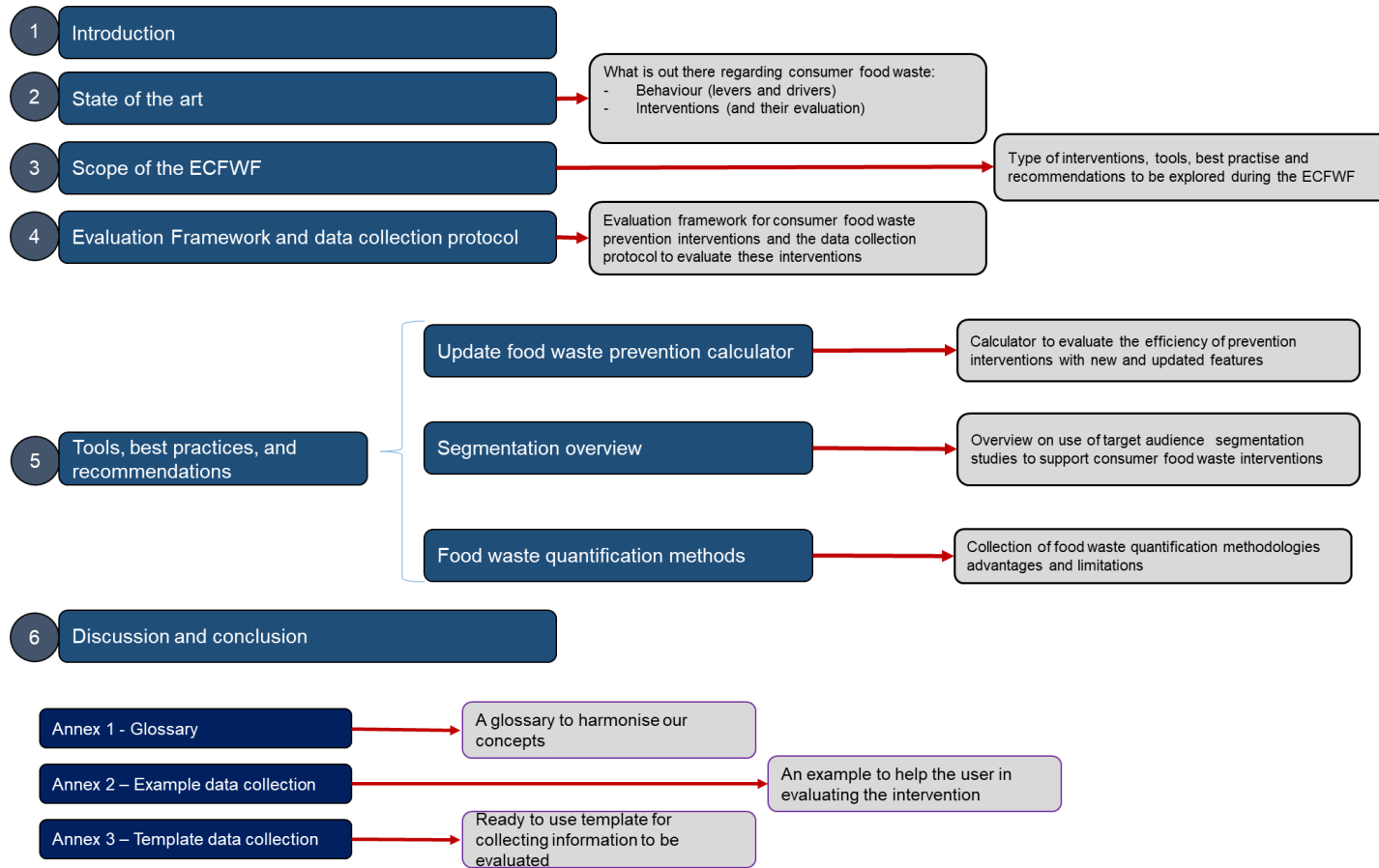
2) Different exchanges with experts during a virtual workshop and the intermediate meeting, as well as through feedback written in surveys and feedback on the documents prepared after the workshop or the draft document of this report.

The report has been developed considering multi-dimensional (i.e. different types of interventions and their link with other initiatives, e.g. promotion of healthy diets) and multi-level applications (i.e. applicable to interventions focused on consumers directly, national governments, local authorities, educational institutions, enterprises, NGOs and other relevant target groups).

This report is structured as follows. Section 1 (this section) introduces the developed work. Section 2 provides state of art showing the outcomes of the different literature reviews and summaries elaborated. Section 3 shows the scope of the ECFWF. Section 4 presents the evaluation framework tailored for consumer food waste prevention interventions as well as the data collection protocol. The following section (section 5) focuses on bringing insights regarding the tools, best practices, and recommendations defined within the scope of the ECFWF and are meant as complementary to the evaluation framework. Specifically, section 5.1 indicates the updates of the food waste prevention calculator implemented during this task. Section 5.2 provides a brief guidance on the use of consumers' segmentation as an instrument to find the appropriate target group across consumers, and section 5.3 offers an overview of methods to quantify food waste. Finally, section 6 brings the discussion of the main findings and conclusions.

Below Figure 2 provides an overview of the report structure.

Figure 2. Summary of the report.



Source: Own elaboration.

2 State of the art

The definition of the scope and the evaluation build on information collected on the evaluation framework issued by the JRC (Caldeira et al., 2019a), of which a summary focusing on food waste prevention at consumer level is available in section 2.1, and in different frameworks identified from 2019-2022 and the application of the JRC framework to certain intervention evaluations (section 2.2).

Moreover, as recommendations addressing consumer food waste need to account for consumer food waste behaviour factors, a review of the scientific and grey literature on the drivers of consumer food waste was conducted within the context of the ECFWF and is presented in section 2.3. The outcome of this review helped the forum define the scope of the study to concentrate efforts on interventions that show greater potential in reducing consumer food waste. In section 2.4 there is a brief summary of literature identifying different classification types of consumers' food waste prevention interventions to frame the evaluation framework and stimulate the discussion when deciding on the types of interventions to be included.

2.1 Assessment of food waste prevention actions: consumers' focus

The aim of the evaluation framework developed by Caldeira et al. (2019a) was to fill the existing research gap on performance evaluation of food waste prevention interventions. Methodologically, the framework originated from a literature review and from the inputs reported by the members of the EU Platform on FLW and DG SANTE. The exercise resulted in the development of a comprehensive evaluation framework, including relevant criteria and related key performance indicators (KPIs) for the evaluation of food waste prevention initiatives.

In Caldeira et al. (2019a) several food waste prevention interventions were collected through a survey and analysed according to the developed evaluation framework. The interventions were categorised as: consumer behaviour change, redistribution, supply chain efficiency, valorisation and food waste prevention governance.

Specifically, for consumer behaviour change, the examples analysed were further grouped under the following sub-categories: awareness-raising/educational campaigns; digital tools for behaviour change, school programs, and awards. The common goal of these actions is to promote a behavioural shift among consumers towards food waste reduction.

The framework introduced criteria and qualitative or quantitative KPIs to measure and evaluate the success of the interventions. These criteria are described below:

Evaluation criteria:

- **Quality of action design:** identification of the problem, definition of the interventions' aims and objectives, design of a strategy to achieve objectives, definition of an implementation plan; implementation of a monitoring system;
- **Effectiveness:** to which degree the action was successful in producing the desired result, i.e. in reaching its objectives (amount of food waste decreased; an action can be considered effective if it is proven that a food waste reduction was achieved). The assessment of an action's effectiveness can be carried out in different ways, according to food waste data availability. In case food waste quantification data is not available, other indicators should be evaluated for establishing an action's effectiveness;
- **Efficiency:** capacity to reach a desired result with the least time/cost/effort. The possible dimensions to assess action efficiency include amount of food waste prevented, net economic benefit, net environmental savings, social benefits and outreach. These should be evaluated against the total costs of implementation (investment costs, implementation costs, operational costs, labour costs, etc.);
- **Sustainability of the action over time:** potential of the action to be sustained over time.
- **Transferability and scalability:** possibility to replicate the same intervention in a different context;
- **Intersectorial cooperation:** ability to form agreements with other actors of the food supply chain, institutions, and civil society.

2.1.1 Consumer behaviour change results from the assessed interventions

The information on food waste interventions was collected via a survey distributed to the members of the EU Platform on FLW. In total, 22 of the 91 submitted answers regarding implemented actions concerned consumer behaviour change. After excluding the ones that did not provide sufficient information or consent in sharing the results, the remaining 15 interventions amounted to 2 school programmes, 1 digital tool (web platform) hosting

educational content to raise awareness on food waste, 1 product innovation – date marking, and the remaining 11 actions were awareness campaigns.

Actions belonging to the ‘consumer behaviour change’ category presented:

- A satisfactory quality of the action design:
 - Many interventions reported a clear identification of the problem and final aim, clearly described the implementation of the action and (when present) the monitoring system to assess the food waste reduction achieved.
 - Instead, only few interventions defined SMART³ objectives and reported a baseline and targets to track their progress towards reaching their goal(s).
 - When defined, most objectives were related to the decrease of the current food waste levels or the increase of awareness of this issue.
 - Half of the actions analysed did not report any KPI that were monitored to assess their effectiveness. In the remaining cases the KPIs used were either based on measures of food waste reduction and/or on measures of the outreach of the action, collected via surveys or interviews.
- Efficiency: in terms of resources used, most actions reported the overall cost of implementation (including the cost of human labour).
- Sustainability over time is tightly linked to availability of funds and external resources, as often these actions do not generate returns; for this reason, to ensure the continuity of the funding in the future, it is relevant to be able to prove that the action was effective in achieving its goal and efficient in terms of resources used. In some of the cases reported, conducting awareness campaigns on food waste was part of a broader strategy, which can ensure the long-term sustainability of these actions – or at least until the strategy remains in place. Some examples are government strategies to reduce food waste and voluntary agreements between food industry actors.
- Transferability and scalability: many were national strategies and therefore already at scale, and possibly transferable to other countries.
- Intersectorial cooperation: moderate degree of cooperation between actors. Widespread awareness campaigns aimed at households were usually run cooperatively by public authorities and consumer associations, while interventions aimed at food services involved food business operators and a coordinating actor, such as consultancies, trade associations and food banks.

2.1.2 Conclusions and further research

The report concluded with some indications for opportunities for further development and improvement of the framework, as well as suggestions for better intervention design. The suggestions included: the need to include SMART objectives and related KPIs, a monitoring system to track the progress of interventions towards achieving their goals as well as including the design of a follow up plan to ensure long-term effects of an action (especially to evaluate cost-effectiveness).

In terms of needs for further research, the report highlighted how a holistic view of the food system for evaluation would improve the understanding of external factors and effects, such as potential burden shifting or spill-overs (i.e. when the environmental savings made in one step of the supply chain simply get transferred to another step or sector). Furthermore, acknowledging the socio-demographic and context-related factors influencing intervention performance could lead to better intervention design.

2.2 Further findings from 2019 and onwards on food waste intervention evaluation

This section summarizes a specific review aiming at scanning the development in scientific literature of evaluation approaches and applications from 2019 onwards, in order to provide food for thought during the scope definition and improve the evaluation framework. The review had few results of novel systemic evaluation approaches. The sources collected were a) the evaluation guidance developed within the REFRESH project by Quested (2019), b) the work done by Wegner et al. (2020), which applied the JRC framework to evaluate a series of food waste reduction interventions performed in Germany between 2017 and 2019, and c) a master’s thesis assessing food waste prevention interventions in Belgium by applying the JRC framework (Hardy, 2021).

³ SMART: specific, measurable, assignable, realistic, time-related

Quested (2019) published a guidance for evaluating interventions preventing household food waste under the REFRESH project. The main objective of the guidance was to provide a methodology for supporting evaluation of interventions targeting households specifically. This work aimed at determining which interventions are effective in terms of food waste prevention at household level.

The guidance covers 3 main areas:

- **Understanding the intervention:** describing how the intervention should theoretically work, including the activities, expected outcomes and how to measure them. It follows an understanding of the interventions' characteristics, its main drivers and levers, and a registration of the intervention (if it has been already tested or not). This area suggests the use of logic mapping as an instrument to guide the intervention design and/or evaluation.
- **Developing the evaluation plan:** identifying the reason behind the evaluation, and by whom it will be conducted. Criteria for assessing suitability of evaluation metrics and indicators are proposed. These criteria are: attainable, clear, comparable, comprehensive, cost-effective, up to date, measurable, redundant, relevant, reliable and sensitive.
- **Implementing the evaluation plan and disseminating the findings:** it includes some suggestions for evaluating, such as being flexible and adaptive to changes, as well as some proposals to disseminate the findings of the intervention.

The guideline is generic enough to be used by a variety of stakeholders who might be involved in evaluation efforts.

The work of Wegner et al. (2020) evaluated different interventions targeting the reduction of wasted fruit/vegetables in different segments of the food supply chain, in bakeries and in school canteens. As mentioned previously, the authors used the evaluation framework developed by Caldeira et al. (2019a), adding a new criterion to the evaluation called "implementation effort and willingness", which refers to the perceived effort and complications to implement a certain intervention from the implementer's side. The framework allowed also to combine interventions. Therefore, in their data collection protocol they included the option of single or bundle interventions and added the option to provide information on how the intervention contributed to national strategies and targets for food waste reduction.

Hardy (2021) evaluated some food waste prevention interventions in Belgium applying the evaluation framework of Caldeira et al. (2019a). A survey to complete the evaluation framework was adapted for the Belgian context and shared among selected organizations in the food waste prevention community. It expanded on the inquiry of specific success factors and barriers. The intersectorial cooperation criterion was omitted in the evaluation of some interventions, although it was highlighted as a relevant element to guarantee scalability.

2.3 Food waste drivers and levers for behavioural change

Within the context of the ECFWF, a literature review to identify key drivers and levers connected to consumer behaviour was performed (Vittuari et al., 2023ab). The work reviewed food waste generation at the consumer level (in- and outside the home), disclosing the mechanisms of behavioural change – drivers and levers - that could represent the base for food waste prevention and reduction interventions. The results of the review were instrumental in identifying the scope of the ECFWF and the developing of the evaluation framework. Drivers – meaning those factors that affect behaviour causing food waste – and levers – opportunities for influencing behaviour – emerge as fundamental elements of intervention design and evaluation.

2.3.1 Food waste literature evolution

From 2010 until December 2021, food waste literature increased exponentially, reaching more than 250 articles published per year in 2021. The topic of consumer food waste was initially observed through the lens of environmental impacts, considering technical aspects such as carbon dioxide emissions and climate-change. Later, the topic of behavioural analysis rose and registered the highest frequency in 2019.

Overall, two major clusters of topics can be identified in consumer food waste publications, one related to consumer behaviour interventions and drivers, and the other to the environmental dimension of food waste. However, regardless of the time evolution, behavioural issues in consumer food waste are today the most investigated in absolute terms.

2.3.2 Conceptualizing consumer food waste with the Motivation-Opportunities-Abilities framework

Food waste at consumer level is recognized as the result of multiple and interconnected behaviours taking place at different moments and stages of the food supply chain (Quested et al., 2013; Setti et al., 2018; van Geffen et al., 2016). Several theoretical and conceptual frameworks have been developed to unravel the complexity of this topic, however, most of them are only rarely applied in concrete contexts but are limited to describing the phenomenon. For instance, the Theory of Planned Behaviour (TPB) and the Motivation-Opportunities-Abilities (MOA) frameworks have been applied to analyse consumer food waste in several contexts and countries.

The TPB explains individual behaviours as a consequence of behavioural intentions. The latter are based on the interaction of three different beliefs described as behavioural, normative, and control. These beliefs impact, respectively, attitudes towards the behaviour under consideration, subjective norms indicating the role of significant others, and perceived behavioural control (which is also impacted by actual behavioural control) (Ajzen, 1991, 2015,). The Motivation Opportunity Ability (MOA) aims to understand the connections between consumers' behaviour and their desire, willingness, and readiness to perform a specific behaviour (Motivation), together with the available and accessible external resources to support the processing of that behaviour (Opportunity), as well as consumer's competencies to conduct the behaviour (Ability). The MOA framework was originally applied to consumer behaviour in processing advertisements information (MacInnis et al., 1991), and was then extended to the field of food waste, to investigate consumers perception of food waste and identify potential mitigation factors (van Geffen et al., 2016. 2019; Vittuari et al., 2020), to evaluate the impacts of food waste reduction campaigns (Soma et al., 2021), and finally, to assess the impacts of social restrictions on food waste given the Covid-19 pandemic context (Vittuari et al., 2021).

2.3.3 Drivers and levers for consumer food waste

The faceted dimensions of consumer food waste - whilst influenced by the food supply chain and the food environment - have been recognized essentially as a behavioural issue where multiple, interrelated and competing drivers play an influential role (Barone et al., 2019; Thyberg and Tonjes, 2016). Therefore, literature shifted its attention towards consumer behaviour, following the hypothesis that stimulating behavioural change might ensure a significant contribution in terms of food waste reduction.

Food waste is the product of individual behaviours that are driven by a wide range of factors, and it is often an undesired consequence of these behaviours. Individual factors such as attitudes, motivations and preferences, are coupled by social and situational factors (Vittuari et al., 2023b)

Food waste can occur throughout the household management stages, including purchasing, storing, preparing, and consuming (van Geffen et al., 2016). Food routines, encompassing lifestyles and habits, can have great potential in the minimisation of households' food waste (Stefan et al., 2013; Stancu et al., 2016; Stancu and Lähteenmäki 2022; Hebrok and Boks 2017; Eičaitė et al., 2021; Karunasena et al., 2021; Nabi et al., 2021; Samotyja and Sielicka-Różyńska 2021).

Out-of-home food consumption can also influence food waste streams in both the ordering and serving and the consuming stage. Relevant food management stages have been described, both in-home and out-of-home in which various behaviours contribute to the generation of food waste. Although these stages are intertwined, separating them provides an opportunity to get a detailed understanding of how food management behaviours are linked to food waste and additionally an understanding of which behaviours might be successful targets to reduce consumer food waste levels.

Table 1Error! Reference source not found. shows a set of examples of drivers and levers corresponding to selected behavioural factors.

Table 1. Behavioural drivers and levers of food waste table.

Behavioural construct	Behavioural factors	Drivers (examples)	Levers (examples)
Psychological factors/individual motivations	Attitude	Media-induced environmental attitude; personal attitudes towards food waste	Emphasize through different communication strategies environmental consequences of food waste to generate better attitudes.
	Awareness	Awareness/perception of consequences of food waste	Emphasize food waste-related issues to raise awareness
	Emotions and engagement	Risk preferences; healthy diet; enjoyment of food	Emphasize food waste-related issues to trigger guilt, concern and other personal emotions (positive or negative)
Norms	Social norms	Environmental concern; injunctive norms; descriptive norms	Promote live and on-line community activities to promote results from good practices for reduction of household food waste, food management advice, and awareness campaigns on environmental consequences of food waste.
	Personal norms	Subjective views on food waste; non-readily changeable behaviours; being a good provider; saving money	Promote monetary and non-monetary incentives for citizens to reduce food waste.
Ability	Skills	Planning, food capability	Promote and Introduce food planning or storage methods, cooking skills, and food reduction tips
	Knowledge	Knowledge of techniques for purchase, manage, and discard food efficiently; knowledge of the real quantity of food waste produced	Promote self-learning methods to increase the knowledge about food waste generated.
Micro level situational factors and opportunities	Time, schedule and lifestyle	Availability of time; time pressure; purchase planning	Promote efficient food planning or storage methods; promote working time organizations leaving more free time to be dedicate to preparation of food (e.g. working from home)
	Availability of tools and/or technologies	Availability of tools and technologies	Provide affordable technology and tools (e.g. smart kitchen tools) to improve optimization of food management
	Food environment	Mismanagement; convenient environment	Design environments that can nudge food waste reduction practices
Demographics	Age		Promote discourses targeted to different generations considering that different age groups are more reactive towards different issues climate and awareness campaigns compared to others.
	Household composition		The attitudes of others family members (partners, friends and family circles) might play a key role in supporting individual behaviours, highlighting the importance of social norms
	Employment status		Employed people tend to produce more food waste, actions targeting workplace might represent a focus area

Source: Adapted from Vittuari et al. (2023a).

2.4 Food waste drivers and levers for behavioural change

With the aim of uncovered information specifically on food waste interventions at consumer level, to help to define the scope of the ECFWF another review was conducted. This examination considered scientific and grey literature on tested and evaluated interventions published from 2019 onwards. Table 2 shows the different intervention types identified.

Table 2. Type of interventions identified in the literature review.

Type of intervention	Description for the purpose of this report
Awareness raising campaign (for behavioural change) Can be a part of: national food waste prevention programs	A process that seeks to inform and educate people about food waste with the intention of influencing their attitudes, behaviours and beliefs towards food waste reduction by providing information about the topic on how to adopt less wasteful behaviour (e.g. through social media campaigns, a newsletter with tips for better food management).
School programs	Education interventions specifically targeted at students to inform them on food waste, its impacts and strategies to counter it.
Economic and material incentives	Targeting consumers' personal and consumption norms, economic and material incentives, e.g. changing pricing models, establishing fines for leaving leftovers (usually for out-of-home settings)
Nudges and changes to consumers' choice architecture	Positive reinforcement and indirect suggestions as ways to influence the behaviour and decision making of groups and individuals. Some examples (adapted from Barker et al. 2021): <ul style="list-style-type: none"> – Default rules: external meal planning, fee-based strategically portioned food ingredients delivery; – Simplification: reducing barriers to target behaviour; – Increase in ease and convenience: making low waste food options available; – Feedback: informing people of the occurrence and impacts of their own past choices; – Commitment: a public pledge to undertake the desired behaviour; prompts: email reminding people to undertake desired behaviours
Social influences/modelling behaviour	Interventions that aim to influence social norms, exploiting the tendency of individuals to conform to the majority, shaping behaviour by giving them information about the behaviour or attitudes of the majority of their reference group (e.g. community focus groups, food sharing practices)
Training and building capability	Programs aiming at increasing consumers' abilities, skills and confidence necessary to engage in food waste prevention practices (e.g. teaching cooking classes).
Regulation	Measures undertaken by government to influence consumers by means of formulated rules and directives.

Sources: Caldeira et al. (2019); Wunder et al. (2019); Quested (2019), Vittuari et al. (2023a).

3 Scope of the European Consumer Food Waste Forum

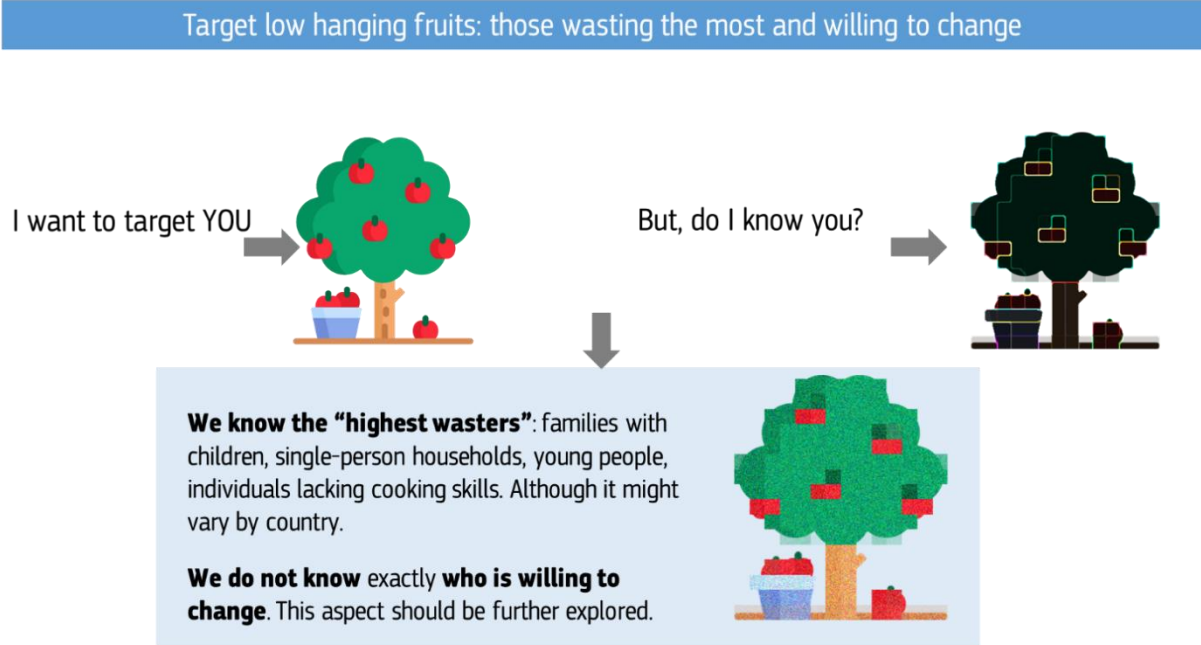
The scope of the ECFWF, i.e. the type of interventions to be targeted and the type of tools, best practices, and recommendations, was defined jointly by the Forum of experts, the JRC and DG SANTE.

The method followed, already described in previous sections included the organisation of an online workshop which took place on February 8 and 9, 2022, lasting 4 hours each day and an intermediate meeting on March 11, 2022, lasting 3 hours.

Ahead of the workshop, a survey was prepared and shared with the experts to generate input for discussions and to prioritise some interventions to be covered under the scope of this work, illustrating some examples obtained from the performed literature reviews (section 2). During the workshop, the results of the survey, as well as the state of the art described in the previous section, were presented. Based on the workshop's outcomes, the JRC elaborated a summary, which was shared with the experts for feedback. The content of the feedback fuelled the discussion of an intermediate meeting, again attended by the Forum of experts, JRC and DG SANTE. In this meeting, the feedback received on the summary of the workshop and further research conducted by the JRC aligning experts' interests and suggestions were presented to reach a final agreement on the scope of the ECFWF. The agreed scope of the project and the insights emerged during the ECFWF exchanges are articulated in the following paragraphs.

- The experts agreed that the priority points regarding the type of interventions and target groups to analyse and evaluate are: Target low hanging fruits, meaning to: find the people who are wasting the most and are also more receptive to change. Currently, there is some information regarding the consumers groups wasting the most, but even less evidence of who are those willing to change (see Kandemir et al., 2020 for one example). Therefore, during the data collection phase, each expert will focus on the consumer groups wasting the most, according to different demographic and lifestyle related characteristics. These groups might vary in their composition according to the geographical location where the intervention is performed. Figure 3 visualizes one of the main outcomes from the discussions arising from the ECFWF expert events on what was needed to maximise consumer food waste prevention interventions.

Figure 3. Main outcome of the ECFWF for the prioritization of consumers to be targeted.



Source: Own elaboration using flaticon (freepik).

- It is important to acknowledge the synergistic effect between intervention types. Different interventions might interact with each other, meaning that, when implemented simultaneously, they could increase or decrease each other's effectiveness. Therefore, interventions to be evaluated could be single or combined.

- The type of interventions agreed follows a recommendation approach. Due to the time limitations of the pilot project, promising interventions are recommended by the Forum as priority for evaluation. Other type of interventions could be evaluated, if justified. The ones prioritised are:
 - Interventions using nudging strategies and promoting a change of consumer's choice architecture. Within nudges, interventions leveraging the power of social influence should be prioritised, as they might be particularly effective in changing behaviour.
 - Education and training - mainly for the new generations. First, because education and training interventions have shown effective in addressing behavioural issues, and secondly, because educating about food, nutrition, and sustainable diets, can also address and influence food waste patterns. Still, the positive effects would accrue more in the long term.
 - Awareness-raising, national food waste prevention programs including communication and dissemination on a large scale, as well as provision of information are also included in the scope of the forum. There is already abundant evidence available on this kind of intervention, but special attention should be given to campaigns specifically including behavioural change components (rather than just information about impacts of food waste).

Regarding the tools, best practices and recommendations, and keeping the focus on multi-dimensional tools as the outcome of the pilot project, the Forum agreed on keeping the focus on:

- Recommendations to improve intervention evaluation: provide information or knowledge sources on how to monitor ongoing interventions. The evaluation section of this report intends to bring this element to the Forum (section 4). The next bullets indicate tools and recommendations aimed to be utilised together within the evaluation framework, while practitioners can also apply them independently of the evaluation framework.
- Update the current food waste calculator (section 5.1) and adjust to a more comprehensive version.
- Target audience segmentation. Provide insights on audience segmentation. This report contains a section (section 5.2) providing a short view on this topic which could be explored during the duration of the Forum.
- A compendium of food waste quantification techniques for practitioners. Section 5.3 reported the most common food waste quantification techniques, including benefits and barriers to using them and available sources to guide practitioners.

These tools, best practices and recommendations should be accessible, easy to use and intuitive. In addition, during intervention evaluation, the Forum experts and JRC will be perceptive to any additional interesting tools, best practices or recommendations which might arise. These could be included in the outcome of this pilot project if they prove to be effective in supporting the design and implementation of food waste prevention interventions.

4 Framework for the evaluation of consumer food waste reduction interventions

The goal of the evaluation framework is to 1) identify effective and efficient interventions and 2) understand the adequacy of the interventions in addressing specific food waste drivers and levers for prevention when addressing consumers.

Box 1. What is an evaluation focused on food waste prevention interventions?

An evaluation is a process to understand an ‘intervention’: how it was implemented, the effects that it had, for whom, how and why. An evaluation examines how an intervention was designed, carried out and what the results of the intervention were. Therefore, evaluations are practically-focused: they investigate what actually happened in practice. Evaluations use a range of analytical methods to collect and analyse information. (Quested, 2019). Within this report, evaluation is the comprehensive assessment of prevention intervention, it has the purpose of emphasizing effectiveness in food waste reduction and behaviour change, as well as featuring the most salient features of intervention design and implementation.

To validate the developed evaluation framework, the experts and the JRC will gather data and identify various evidence-based, practical solutions to prevent food waste at consumer level, including households and food services.

4.1 Types of frameworks identified in the review and proposal of a new one

Capitalizing on the state of the art (section 2.1) and on the results from the literature reviews (section 2.2 and 2.3), the Forum provided multi-disciplinary insights. The following proposal improves and further develops the existing framework (Caldeira et al., 2019a) and tailors it to consumer specific interventions considering the experts inputs.

Figure 4 illustrates all the elements emerging from the identified frameworks and the proposals made by the ECFWF experts. It mainly includes the literature presented in section 2.1 and 2.2, and how it was blended with the experts’ opinions and reflections.

To address the differences among consumers’ food waste behaviours and encourage data collection, the following elements were also considered in the development of the framework:

- Modularity and flexibility to adapt it to the many different typologies of interventions.
- Accessibility from a variety of stakeholders: maintaining a balance between thorough data collection and usability.
- Improvement in the quality of the design: consumers are a particular target which needs to be adequately addressed. Interventions should be tailored to different consumer groups and the evaluation framework should be able to grasp the variability of results arising from diverse intervention types.
- Addition of elements capturing consumers’ behaviour change towards waste reduction.
- Perceived systemic effects: the registration of benefits and trade-offs connected to the interventions, but which go beyond waste reduction

The criteria are described at the end of the section in Figure 5 reflects the outcome of the workshop discussions and proposes the criteria to be considered when evaluating interventions at consumer level.

Figure 4. Current frameworks identified and the proposals made by the experts of the ECFWF.

Caldeira et al. 2019		Quested 2019		Wegner et al. 2020 and Hardy 2021	ECFWF proposals
QUALITY OF THE ACTION DESIGN	Problem identification, definition of the aim, objectives, KPIs, monitoring system	ATTAINABLE	Indicators achievable by the policy or project and should be sensitive to the improvements the project/policy wishes to achieve	Simplification Application of theoretical framework behind the intervention's design Contribution to national plans Implementation effort and willingness	Understanding the change in consumers in terms of: - Motivation - Opportunity - Ability - Beliefs - Perceived control Both quantitative and qualitative
SUSTAINABILITY OVER TIME	Existence of a long term strategy to ensure the continuity of the action	CLEAR	Indicators effectively target the factor which they are measuring and should avoid ambiguity and arbitrariness in the measurement		
TRANSFERABILITY AND SCALABILITY	Action can be/has been transferred to a different content or up scaled	COMPARABLE	The indicator measurement enable comparison over the different life-cycle stages of the policy or project, as well as between different policies or projects		
INTERSECTORIAL COOPERATION	Action relying on the cooperation between different sectors of society	COMPREHENSIVE	The definition and expression of the indicator should be intuitively and easily comprehensible to users		
QUALITATIVE		COST-EFFECTIVE	The cost of collecting and processing the data needed for the chosen indicators should be reasonable and affordable		
EFFECTIVENESS	Food waste was reduced in line with the target set	UP-TO DATE	Indicator information should be as up to date as possible, to reflect current or recent circumstances		
EFFICIENCY	Ration between results obtained and resources invested (*)	MEASURABLE	Indicators defined so that their measurement and interpretation are as unambiguous as possible		
QUANTITATIVE		REDUNDANT	While each input variable measure a discrete phenomenon, separate indicators that measure the same phenomenon may be necessary and desirable		
		RELEVANT	Indicators relevant to the issue being assessed and should be based on understood linkages between the indicator and the phenomena considered		
		RELIABLE	The results from an indicator replicable by different researchers using standard methods. The methods should be stable over time		
		SENSITIVE	Indicators able to reflect small changes in those things that the actions intend to change		
				Provide indicators to measure outcome objectives when impact objectives are not available.	Food waste drivers and levers integration
					Multi-dimensional aspects (e.g. co-benefits, trade-offs). Both positive and negative. Unveil drivers & levers which were not pre-identified.

(*) Considering: Food waste prevented, Net economic benefits, Social benefits, Outreach

Source: Own elaboration.

4.2 Quality of the intervention design

This criterion was originally described in Caldeira et al. (2019a) (See section 2.1); it elaborates on the notion that a well-designed intervention will be more efficient than a poorly designed one. It evaluates how the design of the intervention appropriately matches its aim and objectives. In the present document, this criterion adds elements such as the consideration of food waste drivers and levers as part of the evaluation, as it is seen as way to prioritize action areas for each specific context. For example, when designing an education intervention targeting teenagers attending school, the drivers and levers considered will differ from a nudge-based intervention for food service customers. The first might consider knowledge and attitudes while the second could act upon social or personal norms.

Box 2. Well-designed intervention considerations

- Definition of an aim in relation to contextual setting
- Definition of targets related to outcomes and impacts
- Establishment of a monitoring plan for both impacts and outcome results or if experimental testing was conducted prior to a full-scale intervention implementation
- Indication of appropriate food waste drivers and levers (see section 2.2)
- Performance of pre-intervention activities informing intervention design, such as segmentation of target populations (or review of past experiences)
- Identification or definition of any theoretical framework behind intervention choice or design, as literature suggests that this could lead to increased efficiency (Reynolds et al., 2019; National Academies of Sciences, Engineering, and Medicine, 2020)

The quality of the design is relevant as it involves a reflection on how the intervention was conceived and guides the practitioner in the evaluation following the remaining criteria. The definition of objectives should follow the SMART⁴ approach (Doran 1981), which helps get clear and comparable data when recommending which intervention performs better.

As proposed by WRAP 2010 in their report «Improving the Performance of Waste Diversion Schemes: A Good Practice Guide to Monitoring and Evaluation», objectives can be categorized into input, outcome and impact objectives, for which a complete definition is available in the Glossary section of this report (Annex 1). While input objectives, are not often communicated, outcome and impact objectives are relevant to be reflected and registered in the evaluation. Outcome objectives, as defined within the scope of the ECFWF pilot project, are a valuable benchmark for assessing interventions' performance, as they communicate intermediate results (see Glossary in annex 1). These can be qualitative or quantitative and may vary across interventions as they are flexible to be customised according to the needs of the intervention. Particularly when dealing with **consumers and their behaviour**, impact objectives (i.e., food waste quantities) might not be easy to measure. Therefore, in such cases, **it is recommended to have a set of indicators to measure outcome**, instead of impact, which could **support the evaluation of the intervention's effectiveness**. It is often related to quantitative figures related to food waste reduction amounts. A suggestion of these as KPIs is included in Table 3.

When the quality criterion was discussed within the ECFWF, the experts also stressed:

1. that there is a lack of specific instruments readily available for practitioners to design, conduct and evaluate evidence-based interventions,
2. the need to guide practitioners in matching interventions with the most appropriate target group. For example, by choosing an intervention based on group characteristics, which could be a segment from the population, or by tailoring aspects of an intervention to this group, and
3. the lack of a compendium of food waste quantification techniques to guide practitioners on how to measure food waste.

⁴ SMART: specific, measurable, assignable, realistic, time-related

As regards point 1, section 5.2 was included to explain how target audience segmentation can be used as a method to identify the relevant consumer groups, and to introduce the concept, highlighting its relevance for the design of effective food waste prevention interventions. Regarding the second point a simple introduction to using experiments to evaluate the effectiveness of consumer food waste reduction interventions was developed providing practical tips for practitioners in designing new interventions or adapting existing interventions to a specific context, and to evaluate interventions. This introduction is described in a separated work which will be published as an outcome of the Forum.

To address the third point, section 5.3 provides a review of different consumer food waste quantification methods and discusses the benefits and barriers of methods presented.

4.3 Effectiveness

Systematically evaluating effectiveness is key for comparability, even if it is acknowledged that the ability of an intervention to reach its targets is intrinsically context-specific, thus limiting comparability of interventions taking place in different contexts (Questa, 2019). The effectiveness of a food waste intervention is often measured in terms of achieved decrease in the amount of food waste generated, therefore using as KPI a mass related indicator. This implies having a baseline measurement against which food waste amounts recorded after implementing the intervention are compared. When dealing with consumer food waste, additional indicators are recommended to measure behavioural change. These will depend on the theoretical framework underlying the intervention and/or the consideration of psychographic or psycho-demographic variables. For instance, in the case of an educational intervention aiming at improving the cooking skills of a target group, indicators might capture which new cooking skills were learned as a result of the intervention and how this was achieved, how much existing skills have improved, or how much the motivation to cook and avoid wasting food has changed. These are KPI relevant to evaluate if the intervention worked as it was planned, how effectively reach the established target. As indicated in the provided example (Annex 3), qualitative and quantitative information can be combined. Ideally, effectiveness should target quantitative information for comparison purposes. If this is not possible, qualitative data can be used. In both cases, there is the need to measure the indicators pre- and post-intervention.

Notably, experiments can also be used to test the effectiveness of interventions. Experiments provide the possibility to observe and compare decisions of consumers related to food waste in environments where an intervention is absent, and in which an intervention is present. Creating evidence of food waste reduction in a controlled setting established in an experimental design will establish a counterfactual set, i.e. the evidence that the experimental conditions caused an effect in terms of food waste reduction (see also Questa, 2019). Consequently, experiments do not rely on a comparison of food waste levels before and after introducing an intervention. While there are several challenges and limitations of using experiments to evaluate the effectiveness of consumer food waste reduction interventions, such as limits to external validity and generalizability, they provide a scientifically sound method to rigorously evaluate the effectiveness of these interventions.

4.4 Efficiency

Efficiency is crucial to evaluating the success of an intervention. It evaluates the results achieved in relation to the resources or inputs used. In the food waste prevention context, this information is often provided as the amount of food waste reduction, per capita or per meal, as a function of the cost of running the intervention. The need to provide a ratio between the results and the resources used (e.g. costs) is fundamental to determine if their allocation was appropriate and if it could be optimised. Due to the variety of consumer interventions available, cost structures may vary, but practitioners should account for resources used such as labour costs (including volunteers), investment costs, and daily operational costs. Below there are a few examples to provide this criterion:

- Food waste savings divided by EUROS spent in the intervention. Environmental savings divided by EUROS spent in the intervention (see Section 5.1 for calculation of environmental savings).
- Food waste reduction quantities should always be preferred as the indicator for measuring the intervention's effect, when this data is not available, efficiency can also be expressed as: Number of people reached during the intervention (over a certain period) divided by the cost of the intervention). This measure for efficiency could be insightful for large-scale awareness campaigns which are unable to measure food waste for all participants but should not be prioritized as an indicator for all intervention types.

- Number of people whose average behaviour, motivation, opportunity, abilities/skill, beliefs, perceptions of control, etc. regarding food waste changed in the desired direction, divided by the cost of the intervention.

For evaluating the efficiency of the intervention regarding some features: net economic benefits, net environmental savings, and nutritional savings, there is a calculator already available and further described in section 5.1 as well as more information available in Caldeira et al. (2019a) and De Laurentiis et al. (2021).

4.5 Perceived wider systemic effects of the intervention

In the criterion “Quality of the intervention design” the need to identify and report specific drivers and levers was introduced. This is necessary to apply a more holistic perspective of the food waste problem, which was one of the main gaps and limitations of current frameworks. It is recognized that food waste is not a stand-alone problem, but it is linked to a variety of social, economic and environmental factors – by increasing the practitioners’ perceptiveness to the connections within the context of its operation, new drivers and levers for food waste reduction can be uncovered. With this rationale in mind, the criterion “perceived systemic effects” was included to elicit the connections between the food waste prevention intervention and the multidimensional aspects ingrained in the food system. This criterion can be measured only through open-ended qualitative information as it can vary according to the type of intervention and context, as well as the availability of the information required. For example, whether an intervention elicits positive changes in other aspects of food-related behaviour could be introduced in this section. Some examples of multi-dimensional co-benefits could include a general shift to sustainable consumption patterns towards more plant-based and nutritious diets, increases in food literacy (i.e. increases in understanding of nutrition, health and environmental outcomes of one’s diets), community cohesion (for example because the intervention aimed at consumer food waste takes place as a community cooking workshop), and increased awareness to general environmental issues or reduction in other types of waste (e.g. separation of organic waste from other types of waste leads to improved recycling of other waste flows). Moreover, this criterion also evaluates if the intervention relies on the cooperation between different sectors of society for its successful implementation. Hypothetically, this criterion can encompass also negative perceived effects, such as spill-overs or burden shifting. Some negative effects could include: increased caloric consumption as a result of waste reduction, resources needed for the intervention exceed the environmental savings gained.

4.6 Sustainability over the time

This criterion encompasses two concepts: one pertaining to the longevity of an intervention (Quested, 2019), and one referring to the resources needed to maintain it.

There is currently a lack of sufficient evidence about the longevity of interventions targeting consumer food waste prevention. This is a challenge because understanding the full long-term effect of an intervention depends on data becoming available only once it is concluded. Monitoring requires economic resources, time, and access to data, a barrier which becomes more significant after the conclusion of an intervention; however, monitoring long-term effects after the end of an intervention would give invaluable information of its effectiveness.

Moreover, initiatives expected to last over time would also need to consider all resources needed to keep them alive and adjust them according to consumers’ needs. The presence of organisational support is critical, as well as the availability of infrastructure to keep running (or adjusting) the intervention and the use of technology (or automatized systems) to reduce the resources needed during the monitoring of the intervention.

This criterion helps identify the effects of short and long-term interventions and provides the food waste prevention community with much-needed evidence.







4.7 Transferability and scalability



Being aware that within the consumer behaviour domain in particular, one-size does not fit all, it is a challenge to find interventions that could be translated into different contexts (e.g. from school canteens to public workers canteens; or country related context) and scales (e.g. communication campaign at hospitality in rural areas vs. same campaign at a national scale). However, the practitioner might identify some interventions that can be transferable, or that have already been transferred or upscaled, and from this evidence the food waste prevention community could benefit from evidence of possible barriers or success factors. Moreover, due to the resource intensity of interventions, transferability and scalability is especially relevant in identifying effective and

efficient multi-level interventions which can be replicated. The study Caldeira et al. (2019a) provides some examples on how this criterion could be reported.

A prioritization of the criteria is suggested by the experts. Quality of the intervention design, effectiveness and efficiency are considered the basic criteria to assess the performance of an intervention in reaching its objectives, while sustainability of the action over time and transferability/scalability are optional. A new criterion which emerged from the ECFWF discussion was “perceived systemic effects”. This could shed light on the broader context in which intervention takes place and help connecting the various elements presented in the previous section. As both literature and expert knowledge emphasized the challenge in collecting intervention data, it was concluded that introducing a division between essential and optional criteria could encourage practitioners to undertake evaluation efforts. The barrier of data availability and comparability needs to be overcome in order to deliver evidence-based recommendations for effective food waste reduction.

Figure 5. Criteria proposed to evaluate consumers food waste prevention interventions.

CRITERIA PROPOSED	
 <p>QUALITY OF THE INTERVENTION DESIGN</p>	The intervention design was well defined, planned, and implemented. Identifying the problem and the response is tailored to the target audience and includes measurable, reliable and sensitive objectives.
 <p>EFFECTIVENESS</p>	Food waste reduced or consumer behavioural change was reported according to the target set. The targets established, referred to reach impact or outcome results, are reached.
 <p>EFFICIENCY</p>	The intervention reached the target with the least resources (e.g. time, cost).
 <p>PERCEIVED WIDER SYSTEMIC EFFECTS OF THE INTERVENTION</p>	The intervention brought synergies to speed up the target set (or instead, trade-off to be considered). It also allowed cooperation between different sectors of society.
 <p>SUSTAINABILITY OVER TIME</p>	The understanding of the intervention longevity and its potential to maintain its effects during the time.
 <p>TRANSFERABILITY AND SCALABILITY</p>	Intervention can be/has been transferred to a different context or upscaled. This response to multi-level aspects of the intervention might help identify interventions working well in different contexts.

 Essential
 Optional

Source: Own elaboration

4.8 Data collection protocol

A data collection protocol is proposed in this section, instrumental to the application of the evaluation framework described above. It is recommended to review this protocol before evaluating interventions, as it shows the type of information requested for the evaluation. Furthermore, it could be advised to review the criteria and data requirements for evaluation in advance or in the early stages of intervention implementation, so as to adjust data collection and monitoring if this aspect was not considered in the design phase. Certain terms included in this data collection protocol are defined in detail in the Glossary contained in Annex 1, as these terms were defined as part of the scope definition of the ECFWF. An example is available in Annex 3 to show a completed data collection protocol on a made-up intervention.

If data are available, all fields should be completed. If not, priority should be given to the completion of essential criteria (quality of action design, effectiveness, efficiency and perceived systemic effects) as outlined in Figure 4.

Data gathering

The practitioner might already have data to evaluate the intervention or not. Below, they can indicate which situation applies to their specific intervention.

1. Your intervention, your data

You have already run the intervention or have all the data to evaluate it. Go to the next section.

2. External contact point

If you are not running the intervention and need to get data from those in charge of running it, below is a suggestion to reach the data owner.

— Build a checklist with the relevant information to ask before contacting anyone:

- Prepare a document indicating the aim of the evaluation.
- Identify all information you need to ask beforehand: the next sections will give you further information.
- Consider using tools to facilitate data collection, considering the practitioner and your skills to evaluate the interventions. For example, you can use surveys.
- Provide a clear deadline to facilitate the evaluation procedure
- Give your availability in case any clarification would be required from the external contact point

— Contact the external practitioner and offer a contact point (your email or telephone) to clarify any doubt they might have.

- Contact by email
- Via phone/video call
- Interview
- Survey

If any sensitive information will be collected, establish a plan for the management of this type of information through a simple data management plan, clarifying what information will be shared with the participants or intervention implementer.

A. General information

This section should be filled in with all requested information as it helps to keep track of what interventions have been evaluated and compiled.

A1. Contact point information

Required information	Explanation
Name and surname: Organization(s) implementing the intervention (name and type): Email: Phone:	This section aims to identify the contact points of the intervention.

A2. Intervention description in a nutshell

This section helps to build the information needed to evaluate the quality of the intervention design.

Required Information		Explanation
Title of the intervention:		Indicate the title of the intervention (if any).
<input type="checkbox"/> Intervention currently ongoing: <input type="checkbox"/> Intervention has already ended: Timeline and duration: The intervention started: DD/MM/YY If it has already ended, it lasted until: DD/MM/YY If it is still ongoing, its planned end date: DD/MM/YY Indicate the reporting period in this assessment: From DD/MM/YY to DD/MM/YY		Indicate when the intervention started (Month and year) and how long it lasted (when was the last element triggering behavioural change). If the intervention is currently ongoing, it can be included acknowledging that it is ongoing. Indicate when the monitoring of impacts and outcomes took place.
Type of intervention (select one or more options if/as needed):	<input type="checkbox"/> Nudging strategies and change of consumer's choice architecture Select the type of nudge: <input type="checkbox"/> social influence/leverage of social norms <input type="checkbox"/> default rules <input type="checkbox"/> simplification and increase in ease/convenience <input type="checkbox"/> warnings <input type="checkbox"/> pre-commitment strategies (e.g.: challenges) <input type="checkbox"/> feedback <input type="checkbox"/> other <input type="checkbox"/> Awareness raising campaign <input type="checkbox"/> Education and training <input type="checkbox"/> Other, please, indicate: _____	Select the type of food waste prevention intervention among the proposed options. The intervention could be single or based on a combination of options. If the type of intervention does not reflect any of the options, select other and describe the type of intervention to be evaluated (if needed see the table in Section 2.3).

Required Information		Explanation
	<input type="checkbox"/> Food Business operator, indicate type (e.g. primary producer, retailer, food services) _____ <input type="checkbox"/> Other(s): please, indicate _____	
Target audience	<input type="checkbox"/> Children <input type="checkbox"/> Teenagers <input type="checkbox"/> Families with children <input type="checkbox"/> Families without children <input type="checkbox"/> Students <input type="checkbox"/> People living on their own <input type="checkbox"/> Other types of households (communal living) <input type="checkbox"/> Representative sample of the population <input type="checkbox"/> Other(s), please, indicate: _____	<p>Specify the consumer group(s) targeted.</p> <p>Should you have defined your target following target audience segmentation, please specify.</p>

B. Essential information

B1. Quality of intervention design

Required information	Explanation
Aim of the intervention:	Describe the overall aim of the intervention in detail – in terms of food waste reduction and desired consumer behaviour change (The answer can also be formulated as a hypothesis if the intervention follows an experimental approach)
Objectives	Identify specific objectives in terms of impacts and outcomes, e.g. reduction of food waste per capita, change of social norm around consumption of leftovers, etc.
Target(s) to be reached	Any specific target set for impacts and outcomes explained above, e.g. a 40% FW/capita reduction, X% target audience reached.
<p>Was a baseline measurement conducted?</p> <p><input type="checkbox"/> Yes</p> <p>If so, when was it conducted?</p> <p>What and how it was measured? Please, indicate _____</p> <p>Baseline quantity/quality: _____</p> <p><input type="checkbox"/> No</p>	<p>Indicate if a baseline was set by measuring outcomes and impact indicators before the intervention.</p> <p>If yes, indicate what was measured (e.g. food waste levels), by which method and report any significant figure or relevant information that was registered.</p>
<p>Was the intervention monitored during the implementation?</p> <p>If yes, provide information regarding the methodology utilised and at which points the monitoring took place.</p>	<p>Indicate if the intervention followed any monitoring during its development. If yes, indicate the method used to monitor (e.g. recording certain habits, quantifying food waste, etc.). As well as the frequency, for example one measure 2 weeks after the start of the intervention.</p>
<p>Indicate the food waste driver(s) targeted in this intervention.</p>	<p>Indicate the food waste driver addressed by the intervention. Some examples are: lack of cooking skills and lack of time, lack of tools to measure food while cooking, no clear understanding of food labelling such as “best before” or “use by” dates.</p> <p>(see table in Section 2.3 and Annex 1)</p>
<p>Indicate the food waste lever(s) considered in this intervention.</p>	<p>Indicate the food waste levers addressed with the intervention. Some examples are: emphasise food waste related impacts on the environment, society, or the economy; e.g. promote food planning, share good practices in cooking, integrating FW prevention in broader food education campaigns.</p>

Required information	Explanation
	(see table in Section 2.3 and Annex 1).
<p>Was the intervention designed following a theoretical framework?</p> <p><input type="checkbox"/> Yes</p> <p style="padding-left: 40px;">Which one? Please, indicate _____</p> <p><input type="checkbox"/> No</p>	<p>If relevant, indicate theory or framework which helped in the design of the intervention or the formulation of specific objectives. This could be the incorporation of Motivation - Opportunity – Ability framework mentioned in Section 2.</p>
<p>Was the intervention tested using an experimental approach?</p> <p><input type="checkbox"/> The test included at least one experimental group and a control group.</p> <p><input type="checkbox"/> Participants were randomly allocated to experimental and control group(s).</p> <p><input type="checkbox"/> An expected effect was measured on a dependent variable.</p> <p style="padding-left: 40px;">Which type of experiment did you use (lab, field, online)? Please, indicate _____</p> <p><input type="checkbox"/> None of the above aspects were included.</p>	<p>Indicate if the intervention was tested experimentally, and if yes, what type of experimental methodology was used. An experimental test requires 3 necessary components: a) control group: introducing one specific difference between (at least) two groups while keeping everything else constant, b) randomly allocating participants to these groups, and c) measuring the variable on which you expect an effect. See section 5.2 for further details.</p>
<p>Include if a consumer segmentation study (pre- or post-intervention) was carried out and, if yes, the method that was followed and the main results.</p>	<p>Indicate if a segmentation study was carried out or segmentation was considered in designing the intervention.</p>

B2. Effectiveness

Complete according with the type of intervention evaluated.

Required information	Explanation
<p>Results related to Impact objectives</p>	<p>How much food waste has been prevented?</p> <p>Report on how much food waste has been prevented. This should be a concrete figure – indicating how much food waste was prevented in a specific period of time compared to the baseline (see Table A1). Be clear and consistent about the metrics used throughout the document.</p>
	<p>Were the selected KPIs linked to impact objectives monitored before/during/after the intervention? If yes, could you report the results of the monitoring exercise?</p> <p>In relation to the KPIs and targets mentioned in the previous section B1, indicate all the information related to the reaching of KPIs and specific targets (e.g. reduction of food waste).</p>

Required information		Explanation
	If targets were set in the design phase, were these met?	
	Disclose if any relevant food category was established (e.g. FRUIT, CEREALS) in the food waste measurement, and the waste management option for the unavoided food waste.	If data are available, report on the origin of food waste (e.g. fruit, vegetables, meat). Indicate the commonly used waste management system in the country/city where the action takes place (e.g. landfill, incineration, composting).
Results related to Outcome objectives	Outreach of the intervention	Indicate the outreach of the intervention, for example the number of people aware of the intervention, participation numbers for workshops/events, app users, etc.
	Motivation – ability – opportunity related information	Indicate the element targeted to change consumer behaviour. Some examples: number of people showing increased ability in food management; number of people who report increased motivation; other indicators describing a behaviour that can be linked to food waste reduction (see Annex 1 and section 2.2).
	If targets were set in the design phase, were these met?	
	Method for measuring outcomes	Indicate the method for measuring the outcomes. For example: surveys or interviews.
Social indicators	Jobs created, number of people volunteering, number of people receiving surplus food (e.g. food donation), number of people developing new competences while participating.	Indicate social indicators relevant to the aim of the intervention and the target group.

B3. Efficiency

According to this criterion, the results reached by the intervention according to established KPIs should be divided by the resources utilized to run the intervention, examples of resources used can include:

- Economic resources: costs from implementing the intervention (e.g. material costs, labour costs, investment costs, operational costs, or any division according to how the intervention accounts for costs)
- Environmental resources: avoided impacts from food waste prevention – impacts related to the action implementation (e.g. materials, transportations emissions)

Required information		Explanation
Resources used		
Economic (Indicate the monetary budget allocated to the intervention)	Investment costs (materials, design, purchasing equipment)	e.g. printing of paper food diary; purchase of smart scales
		Consider all inputs, from the intervention design to its implementation. Whenever possible, disclose the budget according to the following classification:

	Labour costs	e.g. wages for researcher	<ul style="list-style-type: none"> • Pre-intervention or initial investments (fixed and variable costs). • Intervention (fixed and variable costs). • Post-intervention (fixed and variable costs).
	Operational costs (logistics)	e.g. fuel for transportation, maintenance	
	Other	e.g. Administrative fees	
	Sum		Acknowledge time allocated to volunteer activities if these were performed to implement the intervention. Include the cost related to training if needed and the number of hours allocated for that.
Environmental	Indicate any environmental input utilized from the implementation of the intervention.		Some examples are: the use of gas, electricity, transportation. See the calculator (see Section 5.1 for further information).
Impact and outcome objectives			
Food waste	Food waste amounts/costs of intervention implementation		<p>Indicate the amounts of food waste prevented and divide by the total economic impacts of the intervention if available</p> <p>Make sure all results and cost of the action refer to the same timeframe.</p>
Outreach	Number of people aware of awareness campaign/cost of the intervention		<p>Calculate the total number of people reached by the campaign (based on KPIs set in Table 3)</p> <p>Divide these by the cost of the intervention (select the denominator that best reflects the efficiency depending on the intervention scale).</p> <p>Make sure all results and cost of the intervention refer to the same timeframe.</p>
Behavioural change	Average behavioural change reported/cost of intervention or in a specific time		Change in motivation or opportunity / cost of the intervention.
Other			
Social indicators	Indicate how much the society –or how many people - benefited from the intervention/cost of the intervention in a specific time.		For example, the number of people benefited from the intervention (in case of food redistribution, the number of people benefited or, at school, the increase in nutritional intake by pupils).

B4. Perceived systemic effects

In this section it is expected to reflect any food waste driver or lever revealed during or after the implementation, either confirming what was hypothesized in the intervention design or uncovering new elements which can help its improvement or replication. Moreover, any synergies or trade-offs could be identified within this criterion (as outlined in the previous section), some non-exhaustive examples of potential synergies could be:

- general improvement in food literacy, more attention to nutrition and health, shifting towards sustainable dietary choices, embeddedness in local food system (taking part in alternative food networks).
 - EXAMPLE: an education intervention targeting primary school children which is based on general knowledge of the food system, of which food waste is an element. Direct measurement can be applied for food waste (occurring in the canteen or at home) but it can be explored whether pupils gain knowledge and awareness of nutrition or environment.
- improved community cohesion, changes in governance structure or increased public participation (i.e., for a city or community).
 - EXAMPLE: a coaching intervention for a neighbourhood leveraging better food management practices leads to connecting isolated inhabitants and greater participation in local food systems.
- negative effects arising from food waste prevention actions, for example: increased caloric intake to avoid food waste, environmental burden-shifting
 - EXAMPLE: an intervention providing doggy bags to restaurant consumers depletes more resources (packaging) than the ones saved.

There are no specific indicators for this criterion, its completion will depend on the type of intervention and the data collection technique.

Perceived systemic effects	Explanation
Indicate any food waste driver identified during or after the intervention:	Indicate any food waste driver identified when performing the intervention or when it was concluded. Some examples are: not having enough time to cook and lack of skills, unavailability of appropriate tools to measure food while cooking, a poor understanding of food labelling (“use by”/“best before” dates). (see Section 2.2 for some examples)
Indicate any food waste prevention lever identified during or after the intervention:	Indicate any food waste prevention lever identified when performing the intervention or when it was concluded. Some examples are: emphasise food waste related impacts to the environment, the society, the economy; promote food planning, share good practices in cooking. (see Section 2.2 for some examples)
Any synergies or trade-offs identified?	Indicate further co-benefits, trade-offs identified when performing the intervention or when it was concluded.
How has the intervention benefitted (or not) from cooperation with other stakeholders and sector of society?	Describe any collaboration or partnership which was instrumental for the success of the intervention.

C. Optional information

C1. Sustainability over time

Required information	Explanation
How long did the intervention have effect on the consumers?	Indicate how long the intervention had a recorded effect on consumers, if this information is available. If it is not known,

	indicate if there is any action to obtain this information.
Is there a monitoring plan in place to keep/adjust the intervention for future continuation/reiteration?	Indicate if there is any plan aiming at maintaining the effect of the intervention, this could be to keep the intervention going over time or to adjust it according to consumers' and other operators needs and aim of the intervention.
<p>Are dissemination and communication activities planned to maintain the outcome or results of the intervention after its official end?</p> <p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p> <p>If yes, please, indicate how (means), target group (to whom the messages are targeted) and the type of resources utilised: _____</p>	<p>Indicate if any dissemination and communication activities are expected out of the intervention. For example, a communication campaign giving some fridge magnets could be to keep the intervention on better planning alive, as well as to communicate the results of an intervention. In this case the means would be fridge magnets to consumers at home as target group and the resources are 1 fridge magnet/family in a sample of 1000 families. The cost of each fridge magnet was 1EUR + sending cost (0.25EUR/unit).</p>

C2. Transferability and scalability

An intervention that can be easily modulated to be also applied in a different context or upscaled if needed is a relevant aspect to consider when evaluating an action. The outcome of this section can help in identifying interventions that are multi-dimensional and multi-level, and consequently are able to respond to the requirements of consumers as well as other main actors engaged in food waste reduction (such as national governments, local authorities, educational institutions, primary producers, companies, non-governmental organisations and other relevant target groups).

Required information	Explanation
<p>Transferability:</p> <p>Was transferability considered before the implementation?</p> <p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p> <p>If yes, which were the barriers identified during the intervention design and during its performance? Which were the enablers?</p> <p>Could the intervention be transferable?</p> <p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p> <p>If yes, under which premises? Which considerations should be taken into account?</p>	<p>Indicate if the intervention was transferred to other context, scales, target groups or implementer of the intervention. If yes, indicate main learnings to be considered.</p> <p>Moreover, indicate if according to the results, the action could be transferable (in the case it was not planned in advance, or in the case it could be transferred to different context). If yes, indicate which considerations should be taken into account for a successful transferability.</p>
<p>Scalability:</p> <p>Was scalability considered before the implementation?</p>	<p>Indicate if the intervention was scaled or not. If yes, provide details regarding key learnings such as enablers and barriers identified.</p>

<input type="checkbox"/> Yes <input type="checkbox"/> No If yes, which were the barriers identified during the intervention design and during its performance? Which were the enablers? Could the intervention be scaled-up? <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, under which conditions? Which considerations should be taken into account?	Moreover, indicate if according to the results, the action could be upscaled (in the case it was not planned in advance, or in the case it could be upscaled into a different scale). If yes, indicate which considerations should be taken into account for successful scalability.
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C3. Other relevant information

This space is dedicated to provide any other information the data collector considered relevant to evaluate the intervention.

C4. Summary of the results

This space is dedicated to providing a summary of the evaluation results – around 250 words – indicating the main weaknesses and strengths of the intervention per criterion evaluated.

According to what was introduced in the quality of intervention design, specific objectives have to be identified and preferably also match suitable targets and monitoring systems. As these will vary according to the type of intervention, so will the relevant KPIs chosen to track progress towards the agreed target(s).

Below, Table 3 shows some suggested KPIs to be included when evaluating the intervention.

Table 3. Suggested KPIs to be included when evaluating the intervention.

Examples		How to monitor?
Impact objectives	— Households: per capita food waste generated over a certain time period (reported indicator)	Section 5.3 (a,b,c)
	— Food services: food waste generated per meal served	
Outcome objectives	Outreach <ul style="list-style-type: none"> — % of people reached by the campaign — % of people reporting a change in behaviour due to the intervention — Quantification/analysis of media reporting insights (e.g. Social media engagement/number of app users/audience or readers) 	
	Participation <ul style="list-style-type: none"> — Number of people taking part in intervention activities (e.g. number of pupils taking part in education activities, community members participating) 	

Examples			How to monitor?
	Behaviour indicators	<p>Fraction or number of people showing change in their:</p> <ul style="list-style-type: none"> — Declared food waste behaviour — Beliefs, attitudes, personal norms — Habits, knowledge (e.g. food literacy) — Skills, awareness — Motivation, opportunity, or ability <p>Alternatively, other indicators that show a change in the above variables can be used. For example, the average change in people’s motivation to reduce food waste in the future.</p>	Section 5.3 (d,f)
	Social indicators	<ul style="list-style-type: none"> — Number of people benefited from the intervention (in case food donations number of people benefited or at school the increase of nutrition intake by pupils) 	

Annex 2 provides the template to use the data collection protocol to complete the evaluation while annex 3 brings an example of its application in an intervention (only created for testing the protocol and illustrational purposes).

5 Tools, best practices, and recommendations

This section provides some tools, best practices and recommendations derived from the ECFWF exchanges.

5.1 Update of the food waste prevention calculator

To evaluate the effectiveness of the identified interventions Caldeira et al. (2019a) introduced a food waste prevention calculator. The calculator was designed to help practitioners (e.g. local, regional or national administrations, food business operators and other actors within the food supply chain) in the identification of potential trade-offs during the design phase of a food waste prevention intervention and to evaluate the net economic and environmental benefits of an ongoing or concluded intervention. The environmental component of the calculator, assessing both benefits and burdens of a food waste prevention action (e.g. emissions saved by avoiding food waste and emissions generated by transporting food to a new location) is based on Life Cycle Assessment (LCA), a pivotal method for addressing multiple environmental impacts and trade-offs. To evaluate the environmental benefits and burdens associated with an action, the user is required to provide information on the types and quantities of food products saved by the intervention, the waste treatment technology that would have been used, and the resources used to implement the intervention. Further information on the functioning can be found in De Laurentiis et al. (2020).

Building on the recommendations provided in the mentioned report and within the ECFWF, this calculator has been expanded to include the following elements:

- Simplification with generic items (general food). Ideally users should input in the calculator the amounts of food waste avoided at product level (e.g. bananas, apples). However, to ease the use of the calculator, in case they do not know the composition of the food waste avoided, they can select as input a generic food item. Furthermore, in case users are aware of this composition but only at the level of food categories (e.g. FRUIT, CEREALS), they are provided with these options.
- Addition of nutritional features. A box has been added to the calculator to provide information regarding the total nutritional value of the saved food. The selected nutritional indicators are those required in the food labels in the EU (Consolidated text: Regulation (EU) No 1169/2011 of the European Parliament and of the Council of 25 October 2011). The calculation of the associated nutrients has been done by using the Norwegian Food Composition Database 2012. The values are calculated according to the food selected and the associated mass.
- Adding new food items and updating the calculation of environmental impacts of food: The number of food items available for selection has been increased from 25 to 45. These food products are based on the basket of food products (BoP food), which is a basket of food products representative of EU consumption for which environmental impacts were calculated using Life Cycle Assessment. Below, Table 4 shows the food products available in the calculator, and Table 5 provides the sources used to model the consumption of the different product groups in the BoP food. For all food items the calculation of life cycle environmental impacts (considering all stages from agricultural production up to consumption) has been updated following the recent updates in the BoP Food models and using the newer version of the Environmental Footprint (EF) impact assessment method (updated from version 2.0 to version 3.0).
- Adding positive messages. The user gets positive messages after calculating the food waste prevented in terms of mass, economic savings and environmental impacts prevented. An example of this message is: “You are saving enough food to feed one person for X days”
- A section with questions and answers (Q&A) has been developed to clarify the benefits and limits of this tool, after the ECFWF experts’ feedback.

Below, Figure 6 shows an illustration of the current user interface of the calculator.

Table 4. Food items available in the Food Waste Prevention Calculator.

Product group	Representative product BoP food (*)	Product group	Representative product BoP food (*)
Meat	Beef	Pre-prepared Meals	Meat-based dishes
	Pork		Biscuits

	Poultry	Confectionery Products	Chocolate
Cereal-based products	Bread	Dairy	Butter
	Pasta		Cheese
	Quinoa		Milk
	Rice	Beverages	Beer
Almonds	Wine		
Cashew	Mineral water		
Fruits	Apples	Fish and Seafood	Canned tuna
	Avocados		Cod
	Bananas		Salmon
	Orange		Shrimp
	Strawberries	Sugar	Sugar
Vegetables	Broccoli	Coffee and tea	Coffee
	Carrots		Tea
	Tomatoes	Eggs	Eggs
Tubers	Potatoes	Legumes	Beans
Oils	Olive oil		Chickpeas
	Palm oil		Lentils
	Rapeseed oil	Legume products	Soy drink
	Soybean oil		Tofu
	Sunflower oil		

(*) In bold the new products added.

Table 5. BoP food data sources.

Product groups	Data source
Meat, Dairy, Oils, Cereal-based products (except quinoa), Beverages, Confectionery, Sugar, Coffee and tea, Fish and seafood, Pre-prepared meals.	PRODCOM database (Eurostat, 2021a) COMEXT database (Eurostat, 2021b)
Tubers, Eggs, Vegetables, Legumes, Fruits (oranges, apples, strawberries, bananas, avocado), Nuts and seeds, quinoa	FAOSTAT (2021)
Legume products	EFSA (2021)

Figure 6. Current user interface of the calculator.

Food waste prevention calculator

INSTRUCTIONS

Action name	Country	Action type	Stage of the supply chain	Action cost in €	Waste treatment option
<input type="text"/>	Spain	Consumer behaviour change	Food services	10000	Other/Unknown

Food waste prevented

Type	Amount	Select Unit *
bread	10	<input type="radio"/> kg
rice	50	<input checked="" type="radio"/> tonne
FRUIT	20	<input type="radio"/> megatonne

* for liquids assume 1 litre = 1 kg

Value of food waste prevented Euros

Action resources

Paper used (leaflets, le	<input style="width: 50px;" type="text"/>	Number (A4 equivalent)
Transport distances	<input style="width: 50px;" type="text"/>	km
Electricity use	<input style="width: 50px;" type="text"/>	kWh

Economic assessment [euros]

Cost of action	-10000 €
Savings from avoided treatment	12384 €
Savings from avoided food pro	127056 €
Total net savings	129440 €

Environmental assessment [kg CO2 eq]

Climate Change

Impact of action	-9.32E+02	kg CO2 eq
Impact of avoided treatment	5.02E+04	kg CO2 eq
Impact of saved food	3.50E+05	kg CO2 eq
Total	3.99E+05	kg CO2 eq

Did you know that EU average citizen waste around 173 kg food/year?
Considering you have saved 80000 kg of food, you are part of the solution.

You are saving enough food to feed one person for 104714 day!

You are saving same carbon dioxide emissions as driving a car for 37684 km!

Total nutritional value of saved food:

Kilojoules	889365835	kJ
Kilocalories	209427002	cal
Fat	632742	g
Saturated fat	100486	g
Carbohydrates	45850229	g
Starch	43894231	g
Sugar	66500	g
Proteins	4707047	g
Salt	81429	g
Dietary fibre	809613	g
Number of saved meals (for an average adult):		
34905		

Source: Own elaboration, interface of the calculator.

5.2 Target audience segmentation: a brief outlook

As introduced in section 5.2, segmentation can be part of experimental testing, specifically to investigate if certain types or specific interventions are more or less effective for specific segments of the targeted population. In addition, the ECFWF experts highlighted the need to familiarize practitioners with the concept of segmentation to increase the quality of intervention design, by better matching specific target groups with appropriate intervention typologies. The literature (e.g. Stöckli et al., 2018) acknowledges this need for greater insights into consumer segmentation.

The aim of this section is to provide some literature on the topic, as food for thought, to be further explored during the duration of the ECFWF or by practitioners interested in the matter.

As outlined in the previous section, we understand segmentation here as the process of dividing a group of individuals into sub-groups (so-called segments) based on specific characteristics of the individuals forming that group. This process resembles the concept of clustering (or cluster analysis), which divides individuals into groups containing individuals that, according to specific criteria, are more similar to each other than to individuals in the other groups.

Consumer segmentation is a key aspect to consider in intervention design: recognising that the heterogeneity within consumers' sensitivities to food waste-related issues (e.g. environmental, ethical and cost) and their behaviour is relevant when selecting and designing the most appropriate intervention as the practitioner can: a) select the type of intervention that best fits a specific segment or b) change the design or content of an intervention based on the segment.

To the knowledge of the Forum's experts, there is a gap in tools and recommendations relating to the application of audience segmentation to reduce food waste reduction. This section aims at narrowing this gap by answering the question "How to perform a segmentation study beyond demographics?"

Consumers can be segmented based on multiple characteristics. Most prominently, by demographics, with characteristics such as age, gender, education level, or geographic location which are used to divide consumers into different segments. Segmentation based on such characteristics is insightful if these characteristics bear a connection to food waste or the effectiveness of food waste reduction interventions. For example, if it is known that elderly people reduce their food waste more when exposed to an environmental awareness campaign, and younger people respond more to an education campaign, it makes sense to select the appropriate intervention based on segmenting the population according to age. However, there are also many other non-demographic variables according to which segmentation and targeting/tailoring of interventions could make sense. These potential variables according to which consumers could be segmented regarding their food waste levels and proneness to behavioural change can be categorized according to the different conceptual frameworks applied to consumer food waste.

There are different frameworks explaining consumer behaviour. The MOA framework already introduced in this report, uses three classes of factors to explain consumer behaviour: motivation, opportunity and ability. Collier et al. (2010) divided the main components of consumer behaviour into attitudes, social norms, habits, and external factors. In addition, the COM-B model (**C**apability, **O**pportunity, **M**otivation, **B**ehaviour) of behaviour enriches the MOA by adding different specifications to the three classes of determinants: Motivation (reflective vs automatic), opportunity (physical vs social), and ability (physical vs psychological). The TPB framework, as stated in previous sections, explains individual behaviours as a consequence of behavioural intentions, based on the interaction of three different beliefs described as behavioural, normative, and control. This theory has been used in segmentation studies, such as the one described below from Marek-Andrzejewska et al. (2021).

The experts from the ECFWF also highlighted the use of psychographics to identify critical consumers' clusters. According to the American Psychology Association, psychographics is a method often used in marketing or advertising that surveys the values, activities, interests, and opinions of populations or population segments (psychographic segmentation) to predict consumer preferences and behaviour.

Below is a summary of a non-exhaustive literature review performed to identify examples of segmentation applied in the context of food and food waste interventions, as well as a summary of the main limits and further research that emerged from the analysed work.

Identified literature

Studies in the UK: The first study that we found using segmentation applied to consumers' food waste behaviour is Mallinson et al. (2016). They designed an online questionnaire asking for demographics, food waste behaviour, attitudinal and behavioural traits associated with food-related activities, as well as consumption frequency of convenience food. The analysis generated 24 food-related lifestyle factors leading to 5 consumer groups that differed with respect to their food-related behaviours. These groups were called: Epicures, traditional consumers, casual consumers, food detached consumers and kitchen evaders. When crossing the results of the groups with the current campaigns in the UK, which aimed to reduce consumers' food waste, it was evidenced that these campaigns could target the principal groups identified, except for a new type of consumer identified (called "casual consumers"). Reaching the latter could be the subject of further research. Another study in UK is the one from Kandemir et al. (2020). They used discrete simulation modelling to feed with data on food products, household size, and national statistics. The researchers modelled seven different types of households to have results from the model representative of the UK population. These seven household archetypes include a combination of different sizes and food-related practices, including food waste. This shows how different consumers could be targeted within the same country.

Study in Ireland: The 2020 results from the National Irish Food Waste Attitudes survey allowed identifying some segments of the population (EPA, 2022). It showed that empty nesters throw away the least amount of food overall, with 22% saying they throw away no food at all. The 25-34 age cohort throws out the most food, particularly fruit, vegetables, and dairy. Together with the 16-24 age, this group appears to lack knowledge of reducing food waste. The study also identified from which media the information about food waste arrived (e.g. from the TV these +55 years old). The combination of demographics with other characteristics will help identify the food waste driver for a specific segment of the population and which way is the most appropriate to reach them.

National population segmentation – Food waste oriented: In Switzerland: Delley and Brunner (2017) aimed at providing recommendations on food waste prevention by conducting a segmentation study on a national population sample in Switzerland. Outcomes of a questionnaire sent out by mail to a random sample were analysed using Cronbach's alpha and based on this, the participants were divided into different segments. The questionnaire contained four sections focusing on food waste drivers, habits, attitudes, knowledge, skills and behaviours related to food and food waste, questions to quantify the food waste, and a section dedicated to demographic-related questions. The study identified seven types of consumers. The behaviour of these different segments can be changed most effectively by using the right interventions.

Segmentation in Denmark: Aschemann-Witzel et al. (2018) clustered consumers according to their reported lifestyle. They identified thirteen dimensions of food (waste)-related lifestyles and five consumer segments. The outcome of this study indicates the typology of consumers that should be involved (or not) in food waste campaigns by including not often considered dimensions (such as cooking interest). The methodology to gather consumer data relied on online questionnaires. The sample was representative of the population in that country with respect to gender, age, region of residence, income, and education.

Segmentation in Poland: The study of Bilska et al. (2020) performed a segmentation study to identify consumer groups with similar behaviours concerning food, emphasising food waste in Poland. All participants were over 18 years old. The three consumer segments were identified combining sociodemographic characteristics with food waste quantification. The study highlights the relevance of knowing the factors influencing consumers' behaviour to tailor food waste prevention interventions. Marek-Andrzejewska et al. 2021, applied the TPB to identify the variables describing consumer profiles. The method for data collection involved an online questionnaire that focused on Polish consumers. It identified three segments of consumers combining sociodemographic variables with the components of the TPB.

Northern European segmentation: Aschemann-Witzel et al. (2021) surveyed five Northern European countries (Denmark, Germany, Norway, Sweden, and the Netherlands) and identified five food consumer segments which would respond differently to food marketing messages. Furthermore, it combined sociodemographic variables with lifestyle characteristics to identify consumers' food waste behaviour.

Sustainable attitude: The study of Gazdecki et al. (2021) collected information regarding food consumers' cognitive, behavioural, and affective components of their attitude towards sustainability. Different consumer cluster types emerged (3) in relation to their sustainable attitude. Petrescu et al. (2020) segmented food consumers from Belgium and Romania based on their attachments to quality, health, and environmental cues of purchased food products. This work did not focus explicitly on food waste but unveiled generated waste habits while analysing food purchase patterns. Funk et al. (2021) identified six segments of consumers regarding

environmentally-friendly food consumption in Switzerland. They identified subgroups that should be considered when developing intervention strategies and communication measures as their differences are wide enough to be treated differently.

Combination of segmentation and food waste audits: In Australia: Borg et al. (2022) identified three different segments of consumers called “Under Planners”, “Over Providers”, and “Considerate Planners” in their study. Segments were the result of combining information from national surveys, in-depth interviews, and food waste audits. This work highlights how interventions design could benefit from a previous segmentation as identifies in each segment the connection between the food waste generated and the control of the environment. For example, in “Over providers” the main food waste flow is originated from ‘doing family’, where food-related decisions are not under the complete control of those responsible for food provisioning. Therefore, interventions could be more focused on purchasing and preparing the right amount skills development.

Limitations and further research

The reliability of self-reported food waste is limited (Delley and Brunner., 2017, Bilska et al., 2020, Aschemann-Witzel et al., 2018; Mallinson et al., 2016). Additionally, the questions asked in the survey are key to discovering consumers' behaviours. Therefore, these should be carefully drafted considering consumers' understanding. Hence, more research should focus on methodological selection – bearing in mind the limitations already identified by the studies presented in this short review – when targeting consumers' behaviour. Moreover, beyond segmentation, intervention testing is advised, according to the consumer segments identified. As already mentioned in this report, there is lack of rigorous and widespread intervention testing related to food waste, and more evidence should be uncovered through testing in the future.

Below, Before going forward with drawing a monitoring plan and, there are some general aspects to keep in mind when measuring food waste:

Table 7. Some aspects to keep in mind when measuring food waste.

Reminder	Why
The definition of food waste should coincide with the delegated act ¹	Data needs to be comparable
Any differentiation between avoidable, unavoidable/edible or inedible food waste should be explicit.	When talking about consumer food waste – the issue of edibility becomes more important. A broccoli stalk might be perfectly edible to one person, but trash to another.
Food waste quantities can further be reported as: Categories of food, divided in relevant food groups (See Section 5.1)	Studies have shown that few products are those that are wasted the most (bread, fruits and vegetables) - knowing the type of food wasted can inform better designed interventions
Choice of measurement method	Priority should be given to the use of robust methods . How to choose the correct method? See Food Loss and waste protocol toolkit

As shown in Table 7, measurement methods for food waste occurring at the level of households, restaurants and food services accepted by the delegated act are: **waste compositional analysis, direct weighing, counting and scanning** (only for restaurants and food services), **and diaries**. The following paragraphs describe these methods and provide advantages and disadvantages of each, along with useful resources to conduct a measurement.

Waste composition analysis

Physically separate, weight and categorise food waste. This method may be used to separate food waste from a ‘waste’ stream that includes other material, which is not food waste. It may also be used to understand the different materials that make up food waste (e.g. types of food categories, or amount of food waste that is food versus associated inedible parts) (Corrado et al. 2019). **How to:** components of the different fractions of the food waste are weighed and analysed with regards to food categories or edible/inedible fractions etc. A sample is separated by hand into different fractions.

Advantages	Limitations
<ul style="list-style-type: none"> — Highly accurate data — It allows progress to be tracked over time — It can be coupled with demographic information (municipal waste collection from selected areas) 	<ul style="list-style-type: none"> — Costly — Time intensive — It requires specific knowledge — It does not distinguish waste occurring in different consumption life-cycle stages (storage, preparation, leftovers, etc.) — Focuses on waste that is put out for collection (not accounting for composting or animal feed, food waste poured into sewage)
<p>Available protocols and resources</p> <p>Guidance on conducting Waste Compositional Analysis from Zero waste Scotland</p> <p>Food loss and waste protocol chapter 4</p> <p>Video tutorial: Conducting a Waste Generation and Characterization Study</p>	
<p>How to overcome limitations:</p> <ul style="list-style-type: none"> — Knowledge requirements: consult the resources provided and build capacity among stakeholders and practitioners — It can be paired with other methods (Surveys and qualitative methods, see later) to inquire about specific food practices and to understand the drivers of food waste. — To simplify the process, identify essential categories to divide the food waste according to the context 	

Direct weighing

Use of scales to measure the weight of food waste. It may or may not include WCA (Corrado et al. 2019). Direct weighing includes all methods in which food waste is directly counted, weighed or otherwise measured as it occurs.

Advantages	Limitations
<ul style="list-style-type: none"> — Highly accurate data — It allows progress to be tracked over time — It allows for tracking of causes 	<ul style="list-style-type: none"> — Costly — Time intensive — Require direct access to waste — Methods may vary and lead to inaccuracies — Social desirability bias when households are conducting the weighing themselves
<p>Available protocols and resources</p> <p>Food loss and waste protocol chapter 1</p>	
<p>How to overcome limitations:</p> <ul style="list-style-type: none"> — Use consistent methodologies by exploring available resources and references: reiterate a methodology used in a similar setting to provide comparable results; report precisely on food categories, boundaries, assumptions made — Provide clear instruction and appropriate tools to single households like in Wharton et al. (2021) for weighing at household level (i.e. provide standard scales for use and provide an easy to follow protocol for measurement) — Weighing aggregate waste combined with sampling of single households/participants can be good way to have estimates — For food services, there are many established commercial solutions which integrate “smart bins” and user interfaces to track waste streams (See Leanpath, Winnow, Orbisk, kitro) 	

Diaries

The practice of a person or group of people keeping a log of food loss and waste that occurs within their home or another unit. The diary usually calls for the participant to log the amount and type of food being lost or wasted, along with how and why the FLW was discarded. Data should be recorded daily for a set period of time.

Advantages	Limitations
<ul style="list-style-type: none"> — Provide information on the types of food waste — It allows for tracking causes — It can gather data on otherwise difficult-to-measure material flows (composting, animal feed) — It can be coupled with qualitative methods 	<ul style="list-style-type: none"> — Relatively costly — High risk of underestimation due to social desirability bias; — Risk of self-reporting inadvertently affecting the intervention effect (the act of keeping a diary can induce behaviour change) potential high dropout rates — It can be difficult to obtain a satisfactory sample size

Available protocols and resources

[Food loss and waste chapter 6](#)

Templates: [Toolkit from WRAP](#) ; [Template for a food waste diary \(Eufic\)](#) ; [Template from Love food hate waste diary](#)

How to overcome limitations:

- A diary can be digitalized for streamlining data collection, for example by requiring study participants to fill in a spreadsheet or input data in an app. This might not be suitable for all consumer segments, as it relies on the technological literacy of the participants.
- If funds allow, incentives can be offered to participants to encourage data collection for the whole period of time and reduce the number of participants dropping out.
- The practitioner should find a balance between accuracy and burden of participation
- All members of the household should be involved in the diary measurement to overcome some aspects of underestimation (i.e. not missing any waste flows)
- If the diary is only used as a measurement tool, it should be designed as such and not to stimulate a reduction

*When possible, direct measurements such as Waste compositional analysis should be prioritized over other methods to gather reliable data. However, as mentioned in the introduction, especially for consumer food waste, other methods can be useful and practical to gather data on food waste quantities, as well as other intermediate outcomes which could indicate the potential effectiveness of an intervention. These methods are therefore **not to be used for reporting according to the delegated act.***

Surveys

Surveys can be useful to gather:

- Self reporting on waste levels, can be made in:
- Absolute quantities (require respondents to directly self-report on the amount of food waste in their home, without the aid of a diary or other instrument, using broad categories in ranges),
- Frequencies (asking people to report how often food is wasted) or
- Visually-based measures (using shapes or reference sizes to give the responses)
- Proportional or relative measures (report the percentage of proportion of food items brought into the household that goes to waste)
- Collect information regarding individuals or entities on attitudes, beliefs and self-reported behaviours on food waste through surveys.

Advantages	Limitations
<p>Larger samples possible Flexible and can be administered online</p> <ul style="list-style-type: none"> — Less costly compared to other methods presented in this section, such as WCA — It requires little effort from participants — Questions on other matters can be integrated in the same survey: questions on the state of the food discarded can be asked, on waste behaviour 	<p>It is not always straightforward,</p> <p>questions must be clear and unambiguous</p> <ul style="list-style-type: none"> — Self-reports that draw on people's memory can lead to unreliable results — Biases are easily introduced (social desirability) — Single respondent bias: if the data is reported on a household basis but the survey is answered by only one person — Underestimation of FW amounts is very possible
<p>Available protocols and resources Best practice measurement of household level food waste</p> <ul style="list-style-type: none"> — Food Loss and Waste Guidance: Surveys 	
<p>How to overcome limitations:</p> <ul style="list-style-type: none"> — Draft straightforward questions that are clear and unambiguous — Review survey questions that have been already used in past scientific studies, for example the sources mentioned above include the list of concepts and questions asked to inquire about consumer food waste behaviours. Depending on available funds, make use of commercial opportunities and market research companies with fixed representative samples that can administer the survey — Inquire about recent consumer experiences (e.g. today and yesterday), because longer term memories are more likely to provide biases. 	

Observation and photos registration

<p>Assess the volume of food waste by counting or using non weight scoring systems with several points to evaluate food leftover by visual method (e.g: using quarter systems to assess leftovers on a plate), observing plate leftovers presence (yes/no), or taking pictures of plates and coding them</p>	
Advantages	Limitations
<p>Not costly Less time intensive for study participants than other methodologies</p> <ul style="list-style-type: none"> — Development of new technologies can increase the possibilities for visual observations of waste 	<p>Imprecise</p> <ul style="list-style-type: none"> — Need to have a common understanding of the observed quantities (among researchers and participants) — In case of photo coding, the input of time from the researchers is needed to interpret the data
<p>Available protocols and resources No structured protocols available, but examples of methodologies have been used in various scientific studies:</p> <ul style="list-style-type: none"> — van Herpen et al. 2019, assessing the validity of photograph coding from a team of researchers compared with direct weighing showed that it can be a reliable method and can relieve some of the burden from study participants. — Garcia-Herrero et al. 2019, combined visual assessment through photographs with direct weighing to understand the relation between portion size and waste in a school canteen. — Getts et al., 2017, propose the validation of the visual assessment of plate waste through a quarter system as a reliable enough method in settings such as canteens and similar food service environments. 	

How to overcome limitations:

- In home observations: The use of video-recording, trashcan camera, and/or automatic electronic weighing of waste in trashcan has the potential for rich information on behaviour and actual food waste, with lower effort for participants and researchers (Van Herpen et al., 2019)
- Quarters method: for food categories which can be easily assessed visually it could streamline quantification: e.g.: ½, ¼ of a sandwich left on a plate.

Qualitative methods

Using interviews, thematic analyses, focus groups and other methods to investigate food waste behaviours, their context and causes

Advantages	Limitations	
Acquire information beyond food waste quantification <ul style="list-style-type: none"> — Flexible — Small samples possible 	It will probably not provide reliable information on food waste quantities <ul style="list-style-type: none"> — Specific knowledge required 	
Available protocols and resources Common qualitative research protocol REFRESH <ul style="list-style-type: none"> — Examples from scientific literature: — Themes from childrens’ drawings to assess the understanding of an education based intervention (Anton-Pèset et al. 2021); — Focus groups after intervention to establish motivation-opportunity-ability components (Soma et al., 2021) 		

How to overcome limitations:

- It is advised to use qualitative methods in combination with waste measurement, can also be used to assess qualitative criteria for intervention evaluation

Technology assisted waste measurement

Use of new technologies to measure and track food waste (AI recognition of pictures, smart scales)

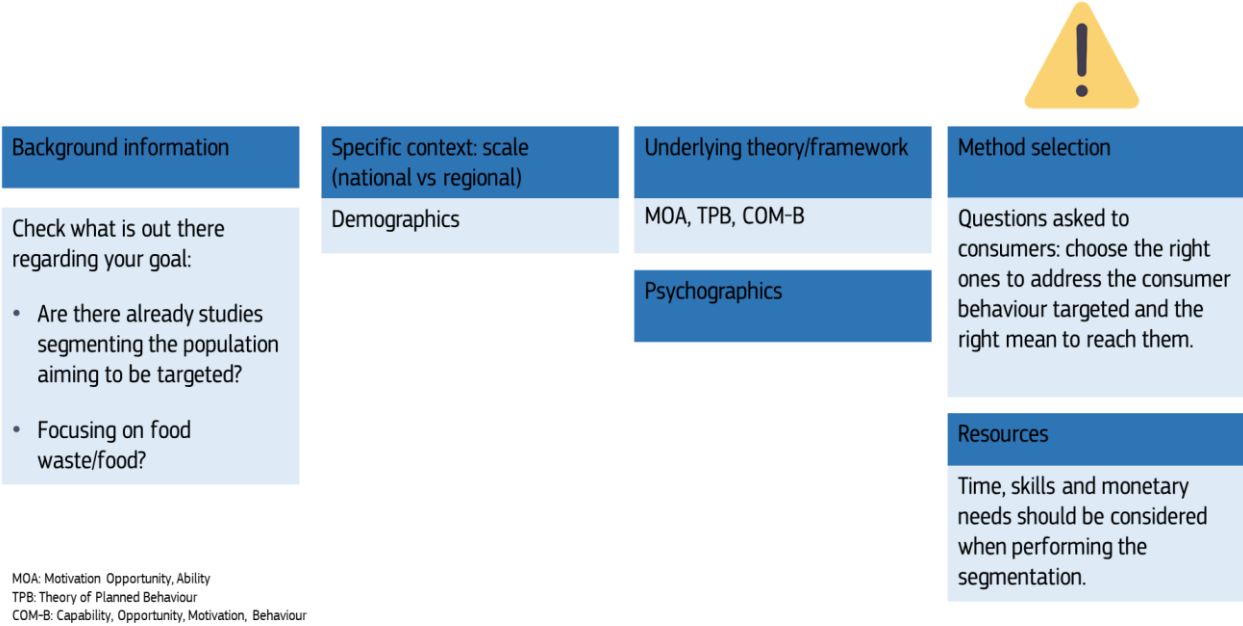
Advantages	Limitations
<p>Potential for facilitating data collection</p> <ul style="list-style-type: none">— Automatic and real time transmission of data to researchers— Less time consuming for participants	<p>Cost of development</p> <ul style="list-style-type: none">— Reliance on new, not yet fully tested technologies which require further validation— Labour requirements in keeping track and interpreting data

No protocols or guidance available as it is a recent innovation, an examples of its testing can be found in Roe et al. (2022), in which an app is used to gather photographs from users along with reason of waste and destination.

Below, Figure 8, provides an overview of the different methodologies, giving it a rating system adapted from Xue et al. (2017). It is important to note that the scores are given from the point of view of the person who is conducting the measurement, not from the point of view of the object of the measurement.

Figure 8 shows the pivotal elements to be considered when performing a segmentation study. First, it is key to identify if there are already studies dealing with this topic in the country the practitioner wants to focus on, e.g. the ones provided in this short review. If data are available, this will help to build the bases to identify the right intervention according to consumers’ characteristics (specific context). If not available, segmentation can be performed using one of the consumers’ behaviour frameworks presented, such as MOA or TPB, to cluster consumers according to the elements of each framework or by using psychographics. The selected method will determine according to which characteristics segments will be created. Applying the TPB will lead to different segments than the MOA framework. The decision of which framework to use should be duly justified.

Figure 7. Summary of the segmentation overview.



Source: Own elaboration.

5.3 Food waste quantification techniques and available protocols

The work of the ECFWF refers repeatedly to the need to monitor and evaluate the impacts and outcomes of an intervention. Lack of quantitative information is one of the main challenges during the evaluation of food waste reduction interventions. While there is a breadth of scientific literature presenting examples of quantification techniques for different settings, the extent to which these methodologies can be easily accessed and applied by a variety of stakeholders is less clear. Lack of resources - time, knowledge, and funds – is acknowledged as a major obstacle in mainstreaming rigorous monitoring, no matter the size of the intervention to evaluate.

As time and funds depend on different constraints, this guide aims at improving the knowledge of quantification methodologies in an approachable manner, by collecting available sources in one convenient document. The following paragraphs collect available methodologies and protocols to guide stakeholders in navigating the intricacies of food waste data collection.

Generally, there are direct and indirect methods for quantifying food waste:

- Direct methods for waste measurement can include weighing, waste compositional analysis, surveys, diaries, records, and observation.
- Indirect methods estimate food waste from various secondary data sources, including modelling, mass balances, proxy data and literature data.

When it comes to food waste quantification at consumer level, and especially in households, direct and precise measurement becomes particularly complicated due to resource intensiveness. In addition, it can require effort and commitment also from consumers themselves who have to actively participate in the monitoring. Most available methodologies provide figures for the specific moment in time when the measurement takes place: this information does not give any indication of trends in food waste generation over time. It is advised to not limit monitoring to a one time exercise but to repeat it over time, especially to gain insights in the long-term effects of an intervention, which constitutes another major knowledge gap regarding consumer food waste.

In 2019, EU legislation has introduced yearly food waste measurement requirements and reporting for Member States; along with these requirements it has proposed a list of methods accepted for waste measurement and reporting according to the stage of the supply chain where waste occurs (see table 6).

Table 6. Accepted methodology for the in-depth measurement of food waste.

Stage of the food supply chain	Methods of measurement				
Primary production	Direct measurement	Mass balance		Questionnaires and interviews	
Processing and manufacturing				Coefficients and production statistics	
Retail and other distribution of food			Waste composition analysis	Counting/scanning	
Restaurants and food services					
Households					

Source: European Commission, 2019

Along with the delegated act, Guidelines on food waste reporting (European Commission, 2021) provide information on data reporting for Member States in accordance with the regulation, but do not guide single stakeholders in collecting primary data.

It is acknowledged that more field work and primary data collection is to be promoted to fill data gaps and verify available estimations (Caldeira et al., 2019b).

Unfortunately, these guidelines on food waste reporting (European Commission, 2021) are directed at Member States’ national government, but do not guide single stakeholders in collecting primary data. More field work and primary data collection needs to be promoted to fill gaps and verify available estimations (Caldeira et al., 2019). This guide is aimed at stakeholders implementing food waste reduction interventions and that are putting in place a monitoring plan.

- Consumer food waste, which is the focus of this guide, can occur in:
- Out of home settings (restaurants, school canteens, corporate restaurants and other food service settings), where consumer food waste entails the amount of total food waste of a food service for serving (plate leftover and display waste) per produced amount of food (Møller et al. 2014)
- In-home settings (in households), where all food waste is consumer food waste, i.e.:
 - The amount of total food waste in household per capita
 - Amount of edible food waste in household per capita
 - Amount of total food waste in household per purchased amount of food in household (Møller et al. 2014)

5.3.1 Measurement methodologies

Before going forward with drawing a monitoring plan and, there are some general aspects to keep in mind when measuring food waste:

Table 7. Some aspects to keep in mind when measuring food waste.

Reminder	Why
The definition of food waste should coincide with the delegated act ¹	Data needs to be comparable
Any differentiation between avoidable, unavoidable/edible or inedible food waste should be explicit.	When talking about consumer food waste – the issue of edibility becomes more important. A broccoli stalk might be perfectly edible to one person, but trash to another.
Food waste quantities can further be reported as: Categories of food, divided in relevant food groups (See Section 5.1)	Studies have shown that few products are those that are wasted the most (bread, fruits and vegetables) - knowing the type of food wasted can inform better designed interventions
Choice of measurement method	Priority should be given to the use of robust methods . How to choose the correct method? See Food Loss and waste protocol toolkit

As shown in Table 7, measurement methods for food waste occurring at the level of households, restaurants and food services accepted by the delegated act are: **waste compositional analysis, direct weighing, counting and scanning** (only for restaurants and food services), **and diaries**. The following paragraphs describe these methods and provide advantages and disadvantages of each, along with useful resources to conduct a measurement.

Waste composition analysis

<p>Physically separate, weight and categorise food waste. This method may be used to separate food waste from a ‘waste’ stream that includes other material, which is not food waste.</p> <p>It may also be used to understand the different materials that make up food waste (e.g. types of food categories, or amount of food waste that is food versus associated inedible parts) (Corrado et al. 2019).</p> <p>How to: components of the different fractions of the food waste are weighed and analysed with regards to food categories or edible/inedible fractions etc. A sample is separated by hand into different fractions.</p>	
Advantages	Limitations
<ul style="list-style-type: none"> — Highly accurate data — It allows progress to be tracked over time — It can be coupled with demographic information (municipal waste collection from selected areas) 	<ul style="list-style-type: none"> — Costly — Time intensive — It requires specific knowledge — It does not distinguish waste occurring in different consumption life-cycle stages (storage, preparation, leftovers, etc.) — Focuses on waste that is put out for collection (not accounting for composting or animal feed, food waste poured into sewage)
<p>Available protocols and resources</p> <p>Guidance on conducting Waste Compositional Analysis from Zero waste Scotland</p> <p>Food loss and waste protocol chapter 4</p> <p>Video tutorial: Conducting a Waste Generation and Characterization Study</p>	
<p>How to overcome limitations:</p> <ul style="list-style-type: none"> — Knowledge requirements: consult the resources provided and build capacity among stakeholders and practitioners — It can be paired with other methods (Surveys and qualitative methods, see later) to inquire about specific food practices and to understand the drivers of food waste. — To simplify the process, identify essential categories to divide the food waste according to the context 	

Direct weighing

Use of scales to measure the weight of food waste. It may or may not include WCA (Corrado et al. 2019). Direct weighing includes all methods in which food waste is directly counted, weighed or otherwise measured as it occurs.

Advantages	Limitations
<ul style="list-style-type: none"> — Highly accurate data — It allows progress to be tracked over time — It allows for tracking of causes 	<ul style="list-style-type: none"> — Costly — Time intensive — Require direct access to waste — Methods may vary and lead to inaccuracies — Social desirability bias when households are conducting the weighing themselves

Available protocols and resources

[Food loss and waste protocol chapter 1](#)

How to overcome limitations:

- Use consistent methodologies by exploring available resources and references: reiterate a methodology used in a similar setting to provide comparable results; report precisely on food categories, boundaries, assumptions made
- Provide clear instruction and appropriate tools to single households like in Wharton et al. (2021) for weighing at household level (i.e. provide standard scales for use and provide an easy to follow protocol for measurement)
- Weighing aggregate waste combined with sampling of single households/participants can be good way to have estimates
- For food services, there are many established commercial solutions which integrate “smart bins” and user interfaces to track waste streams (See [Leanpath](#), [Winnow](#), [Orbisk](#), [kitro](#))

Diaries

The practice of a person or group of people keeping a log of food loss and waste that occurs within their home or another unit. The diary usually calls for the participant to log the amount and type of food being lost or wasted, along with how and why the FLW was discarded. Data should be recorded daily for a set period of time.

Advantages	Limitations
<ul style="list-style-type: none"> — Provide information on the types of food waste — It allows for tracking causes — It can gather data on otherwise difficult-to-measure material flows (composting, animal feed) — It can be coupled with qualitative methods 	<ul style="list-style-type: none"> — Relatively costly — High risk of underestimation due to social desirability bias; — Risk of self-reporting inadvertently affecting the intervention effect (the act of keeping a diary can induce behaviour change) potential high dropout rates — It can be difficult to obtain a satisfactory sample size

Available protocols and resources

[Food loss and waste chapter 6](#)

Templates: [Toolkit from WRAP](#) ; [Template for a food waste diary \(Eufic\)](#) ; [Template from Love food hate waste diary](#)

How to overcome limitations:

- A diary can be digitalized for streamlining data collection, for example by requiring study participants to fill in a spreadsheet or input data in an app. This might not be suitable for all consumer segments, as it relies on the technological literacy of the participants.

- If funds allow, incentives can be offered to participants to encourage data collection for the whole period of time and reduce the number of participants dropping out.
- The practitioner should find a balance between accuracy and burden of participation
- All members of the household should be involved in the diary measurement to overcome some aspects of underestimation (i.e. not missing any waste flows)
- If the diary is only used as a measurement tool, it should be designed as such and not to stimulate a reduction

When possible, direct measurements such as Waste compositional analysis should be prioritized over other methods to gather reliable data. However, as mentioned in the introduction, especially for consumer food waste, other methods can be useful and practical to gather data on food waste quantities, as well as other intermediate outcomes which could indicate the potential effectiveness of an intervention. These methods are therefore **not to be used for reporting according to the delegated act.**

Surveys

Surveys can be useful to gather:

- Self reporting on waste levels, can be made in:
 - Absolute quantities (require respondents to directly self-report on the amount of food waste in their home, without the aid of a diary or other instrument, using broad categories in ranges),
 - Frequencies (asking people to report how often food is wasted) or
 - Visually-based measures (using shapes or reference sizes to give the responses)
 - Proportional or relative measures (report the percentage of proportion of food items brought into the household that goes to waste)
- Collect information regarding individuals or entities on attitudes, beliefs and self-reported behaviours on food waste through surveys.

Advantages	Limitations
<ul style="list-style-type: none"> — Larger samples possible — Flexible and can be administered online — Less costly compared to other methods presented in this section, such as WCA — It requires little effort from participants — Questions on other matters can be integrated in the same survey: questions on the state of the food discarded can be asked, on waste behaviour 	<ul style="list-style-type: none"> — It is not always straightforward, questions must be clear and unambiguous — Self-reports that draw on people’s memory can lead to unreliable results — Biases are easily introduced (social desirability) — Single respondent bias: if the data is reported on a household basis but the survey is answered by only one person — Underestimation of FW amounts is very possible

Available protocols and resources
[Best practice measurement of household level food waste](#)
[Food Loss and Waste Guidance: Surveys](#)

How to overcome limitations:

- Draft straightforward questions that are clear and unambiguous
- Review survey questions that have been already used in past scientific studies, for example the sources mentioned above include the list of concepts and questions asked to inquire about consumer food waste behaviours. Depending on available funds, make use of commercial opportunities and market research companies with fixed representative samples that can administer the survey
- Inquire about recent consumer experiences (e.g. today and yesterday), because longer term memories are more likely to provide biases.

Observation and photos registration

Assess the volume of food waste by counting or using non weight scoring systems with several points to evaluate food leftover by visual method (e.g: using quarter systems to assess leftovers on a plate), observing plate leftovers presence (yes/no), or taking pictures of plates and coding them	
Advantages	Limitations
<ul style="list-style-type: none"> — Not costly — Less time intensive for study participants than other methodologies — Development of new technologies can increase the possibilities for visual observations of waste 	<ul style="list-style-type: none"> — Imprecise — Need to have a common understanding of the observed quantities (among researchers and participants) — In case of photo coding, the input of time from the researchers is needed to interpret the data
<p>Available protocols and resources</p> <p>No structured protocols available, but examples of methodologies have been used in various scientific studies:</p> <ul style="list-style-type: none"> — van Herpen et al. 2019, assessing the validity of photograph coding from a team of researchers compared with direct weighing showed that it can be a reliable method and can relieve some of the burden from study participants. — Garcia-Herrero et al. 2019, combined visual assessment through photographs with direct weighing to understand the relation between portion size and waste in a school canteen. — Getts et al., 2017, propose the validation of the visual assessment of plate waste through a quarter system as a reliable enough method in settings such as canteens and similar food service environments. 	
<p>How to overcome limitations:</p> <p>In home observations: The use of video-recording, trashcan camera, and/or automatic electronic weighing of waste in trashcan has the potential for rich information on behaviour and actual food waste, with lower effort for participants and researchers (Van Herpen et al., 2019)</p> <p>Quarters method: for food categories which can be easily assessed visually it could streamline quantification: e.g.: ½, ¼ of a sandwich left on a plate.</p>	

Qualitative methods

Using interviews, thematic analyses, focus groups and other methods to investigate food waste behaviours, their context and causes	
Advantages	Limitations
<ul style="list-style-type: none"> — Acquire information beyond food waste quantification — Flexible — Small samples possible 	<ul style="list-style-type: none"> — It will probably not provide reliable information on food waste quantities — Specific knowledge required
<p>Available protocols and resources</p> <p>Common qualitative research protocol REFRESH</p> <p>Examples from scientific literature:</p> <ul style="list-style-type: none"> — Themes from childrens' drawings to assess the understanding of an education based intervention (Anton-Pèset et al. 2021); — Focus groups after intervention to establish motivation-opportunity-ability components (Soma et al., 2021) 	
<p>How to overcome limitations:</p> <p>It is advised to use qualitative methods in combination with waste measurement, can also be used to assess qualitative criteria for intervention evaluation</p>	

Technology assisted waste measurement

Use of new technologies to measure and track food waste (AI recognition of pictures, smart scales)	
Advantages	Limitations
<ul style="list-style-type: none"> — Potential for facilitating data collection — Automatic and real time transmission of data to researchers — Less time consuming for participants 	<ul style="list-style-type: none"> — Cost of development — Reliance on new, not yet fully tested technologies which require further validation — Labour requirements in keeping track and interpreting data
<p>No protocols or guidance available as it is a recent innovation, an examples of its testing can be found in Roe et al. (2022), in which an app is used to gather photographs from users along with reason of waste and destination.</p>	

Below, Figure 8, provides an overview of the different methodologies, giving it a rating system adapted from Xue et al. (2017). It is important to note that the scores are given from the point of view of the person who is conducting the measurement, not from the point of view of the object of the measurement.

Figure 8. Summary of quantification methods and their efforts to implement them.

	Time	Cost	Accuracy	Objectivity	Reliability
WCA	★★★★	★★★★	★★★★	★★★★	★★★★
Weighing	★★★★	★★★★	★★★★	★★★★	★★★★
Surveys	★★★☆☆	★★★☆☆	★★★☆☆	★★★☆☆	★★★☆☆
Diaries	★★★☆☆	★★★☆☆	★★★☆☆	★★★☆☆	★★★☆☆
Observation (direct)	★★★☆☆	★★★☆☆	★★★☆☆	★★★☆☆	★★★☆☆
Observation (photo)	★★★★	★★★☆☆	★★★☆☆	★★★☆☆	★★★☆☆

Source: adapted from Xue et al. (2017).

Box 3. Other aspects

- Geographical and temporal scope, as well as system boundaries (what waste flows are the object of the monitoring)
- Sampling and upscaling: if sampling was executed, it should be noted and reported. For example, if a measurement in a catering unit considers only a percentage of meals served through direct weighing and the results are multiplied to obtain a measure for the whole unit, or if only a sample of households are selected for reporting their food waste and the resulting data is used to infer food waste information about a whole city. The period of time should also be considered when upscaling food waste data: for example, if the food waste measurement occurs over two weeks, but the data is then considered to be representative of a whole year, then it should be reported along with any assumptions made to generalize the data.
- Uncertainty assessment: food waste quantification, especially at consumer level, can be uncertain. Food waste measurement endeavours should provide an assessment of the sources of uncertainty (quantitatively if possible, or also acknowledging the sources of uncertainty in a qualitative manner). For example, acknowledging that the measurement method chosen might lead to over/under reporting, reporting any methodological errors occurring during measurement, disclosing any assumptions made.

6 Conclusions

This report illustrates the work performed under the European Consumer Food Waste Forum pilot project. The mandate of the Forum is to increase the knowledge on consumer food waste providing evidence-based solutions that are easily customizable to specific contexts.

A key element developed under this pilot project **was an improved evaluation framework tailored to food waste prevention intervention for consumers**. This framework answers to the request raised by members from the EU Platform on FLW to fill the existing gap in consumer intervention evaluation linked with the origin of the described pilot project. The framework is the product of several literature reviews, and exchanges with the ECFWF experts, always under the coordination of DG SANTE and the JRC.

The proposed framework includes a strong **consumer behaviour orientation** to be able to capture key related aspects, such as motivation (automatic vs reflective), opportunity (social vs physical), and ability (psychological vs physical) to reduce food waste. Moreover, although this work prioritises the use of impact objectives (and therefore the setting of impact indicators) in terms of tangible waste reduction, it acknowledges the importance of outcome objectives, both as proxies for impact and as useful information for uncovering the multi-dimensionality of an intervention's effectiveness.

Aligned with the feedback received from the experts of the Forum, the framework is practical and flexible, in the sense that it is as detailed as the available information allows. Moreover, it covers essential and optional criteria, which allows users to prioritise the efforts in their data collection.

A data collection protocol accompanies the framework to support practitioners in gathering data. This protocol aims at assisting users in circumventing the challenges identified during previous exercises of data collection on interventions, such as the one presented in Caldeira et al. (2019a). Their exercise identified several gaps in the provided information, which were often due to poor quality of the action design (e.g. interventions lacking specific targets to reduce food waste from a baseline condition).

Box 4. The evaluation framework in practice.

Applying the framework and the data collection protocol could support decision-making by prioritising the adoption of interventions, as it reflects the effectiveness and efficiency of such interventions in specific settings. It also identifies further food waste drivers and levers and co-benefits or negative effects linked to the implementation of the intervention. The evaluation framework also copes with the critical point of knowing how long an intervention lasts and how it evolves over time.

This evaluation framework will be applied under the **European Consumer Food Waste Forum context by experts gathering data on existing interventions within the scope defined** in section 3. A prioritization approach was adopted regarding the type of interventions to be evaluated. At the same time, some tools, best practices, and recommendations that will be further explored in the Forum are already described in section 5. The use of this evaluation will help identify the most promising interventions and best practices to be recommended to a wide audience, from policy-makers to any decision maker aiming at moving towards a sustainable food system. It can also be used by any practitioner interested in evaluating existing interventions targeting consumer food waste prevention.

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List of abbreviations and definitions

APA	American Psychological Association
ECFWF	European Consumer Food Waste Forum
FLW	Food Losses and Waste
GHG	Greenhouse gas
KPI	Key Performance Indicator
JRC	Joint Research Centre
LCA	Life Cycle Assessment
MOA	Motivation – opportunity-ability
TPB	Theory of Planned Behaviour
SMART	Specific, Measurable, Achievable, Relevant, Time-Bounded
SDG	Sustainable Development Goal
WRAP	Waste and Resources Action Programme

List of boxes

Box 1. What is an evaluation focused on food waste prevention interventions? 17

Box 2. Well-designed intervention considerations 19

Box 3. Other aspects 55

Box 4. The evaluation framework in practice. 56

List of figures

Figure 1. Overview of the aim, method and results presented in this report. 4

Figure 2. Summary of the report. 8

Figure 3. Main outcome of the ECFWF for the prioritization of consumers to be targeted. 15

Figure 4. Current frameworks identified and the proposals made by the experts of the ECFWF. 18

Figure 5. Criteria proposed to evaluate consumers food waste prevention interventions. 23

Figure 6. Current user interface of the calculator. 39

Figure 7. Summary of the segmentation overview. 49

Figure 8. Summary of quantification methods and their efforts to implement them. 55

List of tables

Table 1. Behavioural drivers and levers of food waste table 13

Table 2. Type of interventions identified in the literature review 14

Table 3. Suggested KPIs to be included when evaluating the intervention. 35

Table 4. Food items available in the Food Waste Prevention Calculator. 37

Table 5. BoP food data sources..... 38

Table 6. Accepted methodology for the in-depth measurement of food waste. 50

Table 7. Some aspects to keep in mind when measuring food waste. 51

Annexes

Annex 1. Glossary

Attitude:

a relatively enduring and general evaluation of an object, person, group, issue, or concept on a dimension ranging from negative to positive. For example, in the context of food waste prevention, previous generation advocacy could have a role in this consumer attitude: *“As a child my grandfather used to tell me that wasting food was not good and he used to relate instances of how he went hungry due to lack of food in their household many times. I grew up with this in mind and was just in-built in me not to waste food”* (definition from APA dictionary of psychology, example from Nunkoo et al. 2020).

Awareness raising intervention:

a process that seeks to inform and educate people about a topic or issue with the intention of influencing their attitudes, behaviours and beliefs towards the achievement of a defined purpose or goal. An attempt to inform a community's attitudes, behaviours and beliefs (adapted from Sayers, R., 2006). These type of interventions are identified in the context of this work to identify how information can influence attitudes, behaviours and beliefs positively in the achievement of a defined purpose or goal.

Behaviour:

(behaviour)

1. an organism's activities in response to external or internal stimuli, including objectively observable activities, introspectively observable activities (see covert behavior), and non-conscious processes.

2. more restrictively, any action or function that can be objectively observed or measured in response to controlled stimuli. Historically, behaviourists contrasted objective behaviour with mental activities, which were considered subjective and thus unsuitable for scientific study. See behaviourism. —behavioural *adj.*

In the context of food waste, habits and emotions have been found important determinants of consumers' intentions to reduce food waste and their current food waste behaviour.

(Definition from APA dictionary of psychology, example from Russell et al. 2017).

Best practice:

an activity that has been proven to be effective in a specific context. For example, the “Love food, hate waste” campaign in the UK was effective in reducing food waste in households in England.

Drivers of food waste:

factors that affect behaviour. These can be more internal, i.e., awareness, attitudes, cognitions, emotions, or more external, i.e., behaviour of others, tools, technologies, etc. In the context of food waste, drivers are these factors leading to food waste generation, for example, the perception of consequences of food waste for climate change (own definition).

Experiment:

1. a system of scientific investigation, usually based on a design to be carried out under controlled conditions, that is intended to test a hypothesis and establish a causal relationship between independent and dependent variables (definition from APA dictionary of psychology).

2. a method in which the researcher deliberately introduces some change into a setting to examine the consequences of that change (definition from Livingstone and Manstead 2020).

Food waste:

from Commission Delegated Decision (EU) 2019/1597 (amending the Waste Directive):

All food, as defined in Article 2 of Regulation (EC) No 178/2002 of the European Parliament and of the Council, that has become waste, where ‘waste’ means any substance or object which the holder discards or intends or is required to discard” (DIRECTIVE 2008/98/EC).

Art. 9(8).2 “food waste does not include losses at stages of the food supply chain where certain products have not yet become food as defined in Article 2 of Regulation (EC) No 178/2002, such as edible plants which have not

been harvested. In addition, it does not include by-products from the production of food that fulfil the criteria set out in Article 5(1) of Directive 2008/98/EC, since such by-products are not waste”.

Art. 9(8).3 “[...] food also includes inedible parts, where those were not separated from the edible parts when the food was produced, such as bones attached to meat destined for human consumption. Hence, food waste can comprise items which include parts of food intended to be ingested and parts of food not intended to be ingested” (EC, 2019).

(Consumer) Food waste:

food waste (see definition above) deriving from consumers.

Habits:

frequency of past behaviour (Russell et al., 2017); a well-learned behavior or automatic sequence of behaviors that is relatively situation specific and over time has become motorically reflexive and independent of motivational or cognitive influence—that is, it is performed with little or no conscious intent. (APA).

Interventions to address consumer food waste:

any activity that is primarily implemented consciously by others (or oneself) in order to reduce consumer food waste (own definition).

Lever:

areas of opportunity for action. Those aspects of behavioural drivers that can be leveraged for systematically influencing food waste behaviour, by means of interventions (own definition).

MOA (motivation – opportunity – ability):

Motivation: desires, willingness and readiness to perform a specific behaviour

Opportunity: available and accessible resources to support processing of behaviour

Ability: consumer competences to conduct a behaviour

Multi-dimensional (interventions and tools):

intervention or tool aiming at reducing food waste in the following dimensions:

1. Aspects characterizing the intervention or tool: action design, monitoring, evaluation and knowledge-sharing.
2. Behavioural constructs impacted: motivation, opportunity and capability to influence food waste-related behaviour.
3. Extended effectiveness: influence and synergies with other initiatives not targeting intentionally food waste reduction but affecting it (e.g. Initiatives dealing with nutrition improvement might lead to food waste reduction).

(own definition).

Multi-level:

multi-level encompasses the different actors that can use the food waste reduction interventions or be targeted with such interventions (own definition).

Nudging:

synonym of modification in choice architecture. Positive reinforcement and indirect suggestions as ways to influence the behaviour and decision making of groups or individuals; Nudging is a concept in behavioural science and political theory which proposes to influence behaviour without coercion (Adapted from Thaler and Sunstein, 2008).

Objectives (Three types according to WRAP 2010):

- Input objective: relate to something that you have done. Input objectives are largely a measure of your own effort/activity.
- Outcome objective: relate to an **intermediate change** that happens as a result of the actions one has taken (e.g. to ensure that 2500 households are aware of the campaign).

— Impact objective: reflect a **tangible** change that has occurred because of the inputs and outcomes (e.g. to achieve a 20% reduction in the food waste generated in the households).

Recommendation:

a suggestion or proposal to improve or progress an intervention. For example, consumer segmentation could improve an intervention's effectiveness as it helps identify the ones that could fit the most according to the audience's characteristics.

Study:

a research investigation conducted for the purpose of understanding, explaining, describing, or predicting some phenomenon of interest. It may be conducted in the laboratory or natural environment, and it may yield quantitative or qualitative data (definition from APA dictionary of psychology).

Tool:

a practical element that helps to address a particular issue. In the context of this pilot project, the food waste prevention calculator is a tool aiming at calculating the net economic and environmental savings of prevented food wasted.

Values:

amoral, social, or aesthetic principle accepted by an individual or society as a guide to what is good, desirable, or important (APA).; Values are 'desirable goals, varying in importance, that serve as guiding principles in people's lives (Steg et al. 2014).

Annex 2. Data collection template

A. General information

A1. Contact point information

Required information
Name and surname: Organization(s) implementing the intervention (name and type): Email: Phone:

A2. Intervention description in a nutshell

Required information
Title of the intervention:
<input type="checkbox"/> Intervention currently ongoing: <input type="checkbox"/> Intervention has already ended: Timeline and duration: The intervention started: DD/MM/YY If it has already ended, it lasted until: DD/MM/YY If it is still ongoing, its planned end date: DD/MM/YY Indicate the reporting period in this assessment: From DD/MM/YY to DD/MM/YY
Type of intervention (select one or more options if/as needed): <input type="checkbox"/> Nudging strategies and change of consumer's choice architecture Select the type of nudge: <input type="checkbox"/> social influence/leverage of social norms <input type="checkbox"/> default rules

	<input type="checkbox"/> simplification and increase in ease/convenience <input type="checkbox"/> warnings <input type="checkbox"/> pre-commitment strategies (e.g.: challenges) <input type="checkbox"/> feedback <input type="checkbox"/> other <input type="checkbox"/> Awareness raising campaign <input type="checkbox"/> Education and training <input type="checkbox"/> Other, please, indicate: _____										
Setting/context of the intervention:											
<p>If pertinent, indicate the food management stage targeted (more options can apply):</p> <table border="0" data-bbox="190 758 2110 1031"> <tr> <td data-bbox="190 758 761 790">Household</td> <td data-bbox="761 758 2110 790">Out of home (food services, schools, canteens)</td> </tr> <tr> <td data-bbox="190 821 761 853"><input type="checkbox"/> Purchasing (in store or online)</td> <td data-bbox="761 821 2110 853"><input type="checkbox"/> Ordering</td> </tr> <tr> <td data-bbox="190 869 761 901"><input type="checkbox"/> Storing</td> <td data-bbox="761 869 2110 901"><input type="checkbox"/> Serving</td> </tr> <tr> <td data-bbox="190 917 761 949"><input type="checkbox"/> Preparing</td> <td data-bbox="761 917 2110 949"><input type="checkbox"/> Consuming</td> </tr> <tr> <td data-bbox="190 965 761 997"><input type="checkbox"/> Consuming (including leftovers)</td> <td data-bbox="761 965 2110 997"><input type="checkbox"/> Take away (doggy bags)</td> </tr> </table>		Household	Out of home (food services, schools, canteens)	<input type="checkbox"/> Purchasing (in store or online)	<input type="checkbox"/> Ordering	<input type="checkbox"/> Storing	<input type="checkbox"/> Serving	<input type="checkbox"/> Preparing	<input type="checkbox"/> Consuming	<input type="checkbox"/> Consuming (including leftovers)	<input type="checkbox"/> Take away (doggy bags)
Household	Out of home (food services, schools, canteens)										
<input type="checkbox"/> Purchasing (in store or online)	<input type="checkbox"/> Ordering										
<input type="checkbox"/> Storing	<input type="checkbox"/> Serving										
<input type="checkbox"/> Preparing	<input type="checkbox"/> Consuming										
<input type="checkbox"/> Consuming (including leftovers)	<input type="checkbox"/> Take away (doggy bags)										
Geographic coverage:	<input type="checkbox"/> Multinational, Indicate countries _____ <input type="checkbox"/> National, Indicate country _____ <input type="checkbox"/> Regional, Indicate region(s) _____ <input type="checkbox"/> Local (neighbourhood, community, living lab) Indicate _____ <input type="checkbox"/> Other: please, indicate: _____										
Actors implementing the intervention	<input type="checkbox"/> Researcher										

	<input type="checkbox"/> NGO (e.g. food bank, consumer- and/or environmental NGO) <input type="checkbox"/> National authority <input type="checkbox"/> Local authority <input type="checkbox"/> School board <input type="checkbox"/> Food Business operator, indicate type (e.g. primary producer, <input type="checkbox"/> Other(s): please, indicate _____
Target audience	<input type="checkbox"/> Children <input type="checkbox"/> Teenagers <input type="checkbox"/> Families with children <input type="checkbox"/> Families without children <input type="checkbox"/> Students <input type="checkbox"/> People living on their own <input type="checkbox"/> Other types of households (communal living) <input type="checkbox"/> Representative sample of the population <input type="checkbox"/> Other(s), please, indicate: _____

B. Essential information

B1. Quality of intervention design

Required information
Aim of the intervention:
Objectives:
Target(s) to be reached:
Was a baseline measurement conducted? <input type="checkbox"/> Yes If so, when was it conducted? What and how it was measured? Please, indicate _____ Baseline quantity/quality: _____ <input type="checkbox"/> No
Was the intervention monitored during the implementation? If yes, provide information regarding the methodology utilised and at which points the monitoring took place.
Indicate the food waste driver(s) targeted in this intervention:
Indicate the food waste lever(s) considered in this intervention:
Was the intervention designed following a theoretical framework? <input type="checkbox"/> Yes Which one? Please, indicate _____ <input type="checkbox"/> No
Was the intervention tested using an experimental approach? <input type="checkbox"/> The test included at least one experimental group and a control group. <input type="checkbox"/> Participants were randomly allocated to experimental and control group(s). <input type="checkbox"/> An expected effect was measured on a dependent variable. Which type of experiment did you use (lab, field, online)? Please, indicate _____ <input type="checkbox"/> None of the above aspects were included.
Include if a consumer segmentation study (pre- or post-intervention) was carried out and, if yes, the method that was followed and the main results.

B2. Effectiveness

Required information	
Results related to Impact objectives	How much food waste has been prevented?
	Were the selected KPIs linked to impact objectives monitored before/during/after the intervention? if yes, could you report the results of the monitoring exercise?
	If targets were set in the design phase, were these met?
	Disclose if any relevant food category was established (e.g. FRUIT, CEREALS) in the food waste measurement, and the waste management option for the unavoided food waste.
Results related to Outcome objectives	Describe the outreach of the intervention:
	Describe Motivation – ability – opportunity related information
	If targets were set in the design phase, were these met?
	Describe the method for measuring outcomes:
Social indicators	Jobs created, number of people volunteering, number of people receiving surplus food (e.g. food donation), number of people developing new competences while participating.

B3. Efficiency

Required information	
Resources used	
Economic (Indicate the monetary budget allocated to the intervention)	Investment costs (materials, design, purchasing equipment) e.g.: printing of paper food diary; purchase of smart scales
	Labour costs e.g.: wages for researcher
	Operational costs (logistics): e.g.: fuel for transportation, maintenance

	Other: e.g.: Administrative fees
	Sum
Environmental	Indicate any environmental input utilized from the implementation of the intervention:
Impact and outcome objectives	
Food waste	Food waste amounts/costs of intervention implementation:
Outreach	Number of people aware of awareness campaign/cost of the intervention:
Behavioural change	Average behaviour change reported/cost of intervention or in a specific time:
Social objectives	
Social indicators	Indicate how much the society –or how many people - benefited from the intervention/cost of the intervention in a specific time.

B4. Perceived systemic effects

Required information
Indicate any food waste driver identified during or after the intervention:
Indicate any food waste prevention lever identified during or after the intervention:
Any synergies or trade-offs identified?

C. Optional information – except summary for the ECFWF pilot project

C1. Sustainability over time

Required information
How long did the intervention have effect on the consumers?
Is there a monitoring plan in place to keep/adjust the intervention for future continuation/reiteration?
Are dissemination and communication activities planned to maintain the outcome or results of the intervention after its official end? <input type="checkbox"/> Yes <input type="checkbox"/> No
If yes, please, indicate how (means), target group (to whom the messages are targeted) and the type of resources utilised: _____

C2. Transferability and scalability

Required information

Transferability:

Was transferability considered before the implementation?

Yes

No

If yes, which were the barriers identified during the intervention design and during its performance? Which were the enablers?

Could the intervention be transferable?

Yes

No

If yes, under which premises? Which considerations should be taken into account?

Scalability:

Was scalability considered before the implementation?

Yes

No

If yes, which were the barriers identified during the intervention design and during its performance? Which were the enablers?

Could the intervention be scaled-up?

Yes

No

If yes, under which conditions? Which considerations should be taken into account?

C3. Other relevant information

--

C4. Summary of the results – not optional for the ECFWF

--

Annex 3. Example of application

Example intervention (school program)

Contact point information
Name and surname: Mario Rossi
Organization(s) implementing the intervention: SustEd ONLUS, Comune of Milano Education department. (It)
Email: mariorossi@susted.org
Phone: XXX

Title of the intervention: Obiettivo zero spreco	
Rationale: the main objective of the intervention was to engage with teenagers on the topic of food, the food system and its impacts, to increase their knowledge and skills. The way the intervention was executed was in the form of a 1-hour weekly lesson within the civic education/health class for teenagers aged 14 to 17 in local high schools of Lombardy region. The classes were divided in intro sections sharing facts and figures and then had a more practical side. The 2-month education program was divided in modules: Food production, food waste, nutrition & health. 2 Field trips were also organized: one to a local farm, one at the composting facility of Milano and in addition there was one cooking class.	
X Intervention currently ongoing: <input type="checkbox"/> Intervention has already ended: Timeline and duration: The intervention started: 01/03/2022 If it has already ended, it lasted until: DD/MM/YY If it is still ongoing, its planned end date: 30/04/2022 Reporting period: 01/03/2022- 01/04/2022	
Type of intervention (select one or more options if/as needed):	<input type="checkbox"/> Nudging strategies & change of consumer's choice architecture Select the type of nudge: <input type="checkbox"/> social influence/leverage of social norms <input type="checkbox"/> default rules <input type="checkbox"/> simplification and increase in ease/convenience <input type="checkbox"/> warnings <input type="checkbox"/> pre-commitment strategies (e.g.: challenges) <input type="checkbox"/> feedback <input type="checkbox"/> other <input type="checkbox"/> Awareness raising campaign xEducation and training <input type="checkbox"/> Other, please, indicate: _____
Setting/context of the intervention: High school	

Objectives:

We expected a reduction in food waste as a result for the education interventions, although this is not the primary objective.

It is expected that motivation and ability of students in regards to food related knowledge and skills will increase.

Target(s) to be reached:

We expect to engage actively at least 60% of every classroom participating in the project (about 17 students in every classroom responding positively to the intervention)

We expect 60% increase in students reporting gaining more knowledge about food waste and its impacts, and strategies to counter it

We expect a decrease in the food waste reported over the period but do not set targets for this objective

Was a baseline measurement conducted? If so, when and how was it conducted?

Yes

Which method? Please, indicate _____

No

Was the intervention monitored during the implementation? If yes, provide information regarding the methodology utilised and at which points the monitoring took place.Yes, food waste amounts were monitored through a food diary in the last two weeks of the intervention

Participation was monitored through attendance records

Food waste behaviours, attitudes, knowledge were monitored with surveys (at the start and at the end of the intervention)

Indicate the food waste driver(s) targeted in this intervention:

Awareness/perception of consequences of food waste, environmental concerns

Indicate the food waste lever(s) considered in this intervention

Emphasize food waste-related issues to trigger guilt, concern, and other personal emotions (positive or negative); Promote live and on-line community activities to provide results from good practices for reduction of household food waste, food management advice, and awareness campaigns on environmental consequences of food waste

Was the intervention designed following a theoretical framework?

Yes

Which one? Please, indicate: Motivation Opportunity Ability

No

Was the intervention tested using an experimental approach?

- The test included at least one experimental group and a control group.
- Participants were randomly allocated to experimental and control group(s).
- An expected effect was measured on a dependent variable.

Which type of experiment did you use (lab, field, online)? Please, indicate _____

X None of the above aspects were included.

No, it is building on previous experience with education interventions from the actors implementing the intervention

Include if a consumer segmentation study (pre- or post-intervention) was carried out and, if yes, the method that was followed and the main results. A segmentation of the sample was not executed

Effectiveness		
Results related to Impact objectives	How much food waste has been prevented?	80g/household/week
	Were the selected KPIs linked to impact objectives monitored before/during/after the intervention? if yes, could you report the results of the monitoring exercise?	Outreach targets were met because all the students in each classroom actively participated in the class (against a target of 60%)
	If targets were set in the design phase, were these met?	60% of increase in average reported knowledge about food waste was met A fixed decrease in food waste quantity was not fixed but a slight decrease was recorded through the food waste diary that was kept for two weeks by participants.
	Information on food waste prevented: categories, waste management system.	Information on food waste prevented: categories, waste management system: urban food waste in Milano is mostly used to make compost (there is a kerbside recycling system).
Results related to Outcome objectives	Outreach of the intervention Outreach of the intervention: people aware of the intervention, participation numbers for workshops/events, and app users. The intervention was carried out in 3 high schools, in 3 different classes (size of classes ranged between 25 and 32)	
	Motivation – ability – opportunity related information	Motivation – ability – opportunity related information
	If targets were set in the design phase, were these met?	The intervention mainly increased motivation and opportunity, while ability was less targeted
	Method for measuring outcomes (monitoring system for outcomes)	

	<p>Method for measuring outcomes:</p> <p>A short survey was administered at the end of the final lecture + oral feedback session with students</p>
Social indicators	Jobs created, number of people volunteering, number of people receiving surplus food (e.g. food donation), number of people developing new competences while participating.

Resources used	
Economic (Indicate the monetary budget allocated to the intervention)	Investment costs (materials, design, purchasing equipment): Wages for researcher 350€ /school
	Labour costs: Field trips transportation 150€ x 2 = 300€
	Operational costs (logistics): Administrative fees 100€
	Other: /
	Sum: 12 + 300 + (350 x 3) = 1462€ (2 months intervention)
Environmental	Gas consumption for field trip (both trips were about 80 km round trip with rented bus) Paper for food diaries Paper food diary 12 € total
Impact and outcome objectives	
Food waste	<p>Food waste amounts / costs of intervention implementation</p> <p>Indicate how much food has been prevented to be wasted per (Select any of the options below):</p> <p><input type="checkbox"/> Capita</p> <p><input type="checkbox"/> Meal</p> <p>X Family/household :</p> <p>200g/household/week average \Rightarrow cost per pupil: $2000/27 = 74 \Rightarrow 0.08g \times 52$ (assumption that this is continued for a year) = 4.16 kg/hh/year \Rightarrow 84 (number of households participating) x 4,16 = 349.44 - year of continued behaviour after intervention = 349.44 /1462 = 0.24 kg/euro (4 euros for every kg of waste prevented)</p>
Outreach	Number of people aware of awareness campaign / cost of the intervention

	84 pupils engaged in classes – matching number of households for diary (320 people reached if counting also households, average household size: 3.8 people)
Behavioural change	<p>Average behaviour change reported / cost of intervention</p> <p>60% of survey respondents showed an average increased awareness of food waste issue</p> <p>80% stated environmental impact of food waste as a primary concern</p> <p>75% of survey respondents said that the information received in the various classes reported increasing their attention to food waste problems</p> <p>70% of survey respondents reported talking to their families about things learnt in school</p>
Social objectives	
Indicate how much the society –or how many people - benefited from the intervention/cost of the intervention in a specific time. NA	

Perceived systemic effects
<p>Indicate any food driver identified during or after the intervention:</p> <p>Non-readily changeable behaviours</p>
<p>Indicate any food lever identified during or after the intervention:</p> <p>Skills capabilities, knowledge of techniques for purchase, manages and discard food efficiently</p>
<p>Other synergies (positive or negative) identified?</p> <p>As the intervention focused on a strong synergy with other important educational matters related to the general food system, there are many co-benefits to mention related to awareness raising in young teenagers, stimulating an interest in food and its complex relations to the environment and society.</p>

Sustainability over the time
<p>How long did the intervention have effect on the consumers?</p> <p>Not evaluated.</p>
<p>Is there a monitoring plan in place to keep/adjust the intervention for future continuation/reiteration?</p> <p>No planned.</p>
<p>Are dissemination and communication activities planned to maintain the outcome or results of the intervention after its official end?</p> <p><input checked="" type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p> <p>If yes, please, indicate how (means), target group (to whom the messages are targeted) and the type of resources utilised: The use of social networks to share the results of the intervention. 3 post a week for 1 month, using relevant # (food waste fight, support 12.3, etc.)</p>

Transferability and scalability

Transferability:

Was transferability considered before the implementation?

Yes

No

If yes, which were the barriers identified during the intervention design and during its performance? Which were the enablers?

No relevant barriers or enablers were identified.

Could the intervention be transferable?

Yes

No

If yes, under which premises? Which considerations should be taken into account?

Yes, it was meant as a trial run for an intervention to be launched in all the high school of the region XX, this was a pilot run and will be further transferred in the future if funding allows

Scalability:

Was scalability considered before the implementation?

Yes

No

If yes, which were the barriers identified during the intervention design and during its performance? Which were the enablers?

No relevant enablers or barriers were identified.

Could the intervention be scaled-up?

Yes

No

If yes, under which conditions? Which considerations should be taken into account?

A template with the educational materials and guidance to set up the intervention could be shared and proposed as part of a broader school curriculum which can be implemented in all the secondary schools of the region with limited resources.

Other relevant information

Promising results with a good scalability potential. Longevity of the intervention might be further study to capture the whole intervention picture.

Summary of the results – not optional for the ECFWF

NA

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