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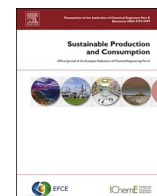
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Let's get flexible: Exploring adaptable consumption toward reducing household food waste in the Netherlands

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ABSTRACT

Food waste remains a critical global challenge, undermining sustainability and straining food systems. This study investigates adaptable consumption as a transformative strategy for reducing household food waste, emphasising its role in enhancing resilience within food systems. Adaptability of consumption empowers households to adjust food-related behaviours in response to changes in food availability, household needs, and other disruptions. Through cultural probes and semi-structured interviews with 11 Dutch households (43 participants), this study identifies five actionable opportunities for supporting consumers in more adaptability toward food waste reduction: 1) supporting flexible meal moments, 2) reclaiming food edibility, 3) reintegrating food into routines, 4) integrating feedback loops, and 5) playing into life-changing moments. These opportunities represent critical moments in time, behavioural routines, or dynamics where food waste-reducing behaviours can be successfully introduced and fostered. The study identifies practical recommendations within each opportunity, including implementing sensory-driven food labels to guide safe consumption decisions, introducing storage tools to minimise waste, and leveraging digital tools to provide actionable feedback, which can support households in adopting sustainable and waste-reducing practices. By integrating such interventions, stakeholders can enable households to adopt concrete, sustainable practices that align with systemic goals for food waste reduction and resilience.

1. Introduction

Resilience in food systems relies heavily on the capacities for adaptability and flexibility, which enable responses to mounting pressures such as climate change, resource depletion, and socio-economic instability (UNEP, 2024). These challenges threaten food availability, affordability, and quality, making the need for resilient food systems more urgent than ever (Rotz and Fraser, 2015; Tendall et al., 2015). Resilience, as defined by Tendall et al. (2015), is the “*capacity over time of a food system and its units at multiple levels to provide sufficient, appropriate, and accessible food to all, in the face of various and even unforeseen disturbances*.” This definition highlights that resilience goes beyond robustness; it requires the ability to adapt to evolving circumstances and remain flexible in the face of disruptions. Such capacities are essential for food systems to navigate both immediate and long-term challenges while avoiding undesirable outcomes like food insecurity or environmental degradation (Tendall et al., 2015). Resilience and sustainability are, therefore, deeply intertwined, as maintaining a food system’s long-term functioning—a core principle of sustainability—is fundamental to

achieving resilience (Rotz and Fraser, 2015; Tendall et al., 2015).

Adaptability and flexibility, though distinct, are complementary dimensions of resilience that operate across multiple levels of the food system, from global supply chains to individual households (Adger et al., 2005). Adaptability involves the capacity for long-term adjustments to meet changing conditions, such as adopting new dietary patterns or preservation techniques (Carpenter and Brock, 2008). In contrast, flexibility enables short-term responses to immediate disruptions without requiring structural change, such as substituting ingredients or modifying meal plans (Adger et al., 2005). While much of the adaptability and flexibility demonstrated in food systems has been reactive—addressing past or ongoing challenges—these capacities can also be anticipatory, allowing proactive measures to strengthen resilience (Adger et al., 2005).

To date, most research on adaptability and flexibility has focused on food production and supply chains, exploring strategies such as crop diversification (Darnhofer et al., 2010), and technological innovation for production and processing efficiency (Brenner et al., 2014; Van Wezel et al., 2006; Yu et al., 2024). However, there has been relatively little

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attention to how these concepts apply at the consumer level, where households play a crucial role in fostering resilience through their consumption practices (Beddington et al., 2012; Tendall et al., 2015). For a food system to be resilient, it must also support households in adapting consumption patterns over time while enabling flexible responses to situational challenges without compromising nutrition or well-being (Goss et al., 2023, 2025).

A key area where consumer-level adaptability and flexibility could significantly enhance food system resilience is in reducing household food waste (Beddington et al., 2012). Globally, food waste accounts for approximately one-third of all food produced annually, with households responsible for 50 % of this waste in Europe (Tostivint et al., 2016). This food waste has severe consequences for society, placing pressure on production resources, the environment, and public health, and it poses significant economic costs across the food chain (UNEP, 2024). Recent studies have explored these concepts on the consumer level, such as in flexible meal planning (Cooper et al., 2023; Heidenström and Hebrok, 2022; Pickering and Reynolds, 2023), and consumer flexibility in food purchases (Ghosh Chowdhury et al., 2018; van Herpen and Jaegers, 2022), but few have examined these as a central strategy for reducing food waste. Notably, Cooper et al. (2023) are among the first to place flexibility at the core of an intervention specifically aimed at minimising household waste, signalling an emerging research area with considerable potential.

In the literature and the present study, *adaptable consumption* is proposed as a practice for enhancing household resilience by enabling households to adjust their food provisioning activities toward food waste minimisation (Béné, 2020; Goss et al., 2023, 2025). It integrates flexibility through short-term adjustments like substituting ingredients or modifying meal plans and adaptability through practices such as using suboptimal food and improving storage techniques in the long term. The present study delves deeply into the everyday practices and lived experiences of households, uncovering how adaptable consumption unfolds within their daily food provisioning and waste routines. It examines how Dutch households engage in adaptable consumption and identifies opportunities to foster both flexible and adaptive waste-reducing behaviours and practices. By positioning adaptability at the core of a household-level strategy for food waste reduction, this research provides insights into how changes in household practices can support resilient food system goals.

2. Literature review

2.1. Adaptability and flexibility in household food practices

Adaptability in household food practices encompasses longer-term, structural changes aimed at embedding sustainable and waste-reducing behaviours into daily life (Goss et al., 2023, 2025). This includes the adoption of sustainable dietary patterns, such as integrating seasonal and locally sourced produce into meal planning or incorporating plant-based proteins to reduce environmental impact. Seasonal eating, for example, not only aligns household consumption with the natural availability of food but also reduces reliance on resource-intensive food production and storage practices (Boon and Schifferstein, 2022; Macdiarmid, 2014). A study by O'Neill et al. (2022) found that seasonal produce boxes encourage consumers to adopt more preservation techniques, embrace less familiar ingredients, and adjust their shopping routines based on the produce provided, thereby becoming more adaptable. Such practices foster a proactive approach to food management and enable preparation for future uncertainties.

Conversely, flexibility in household food practices refers to the ability of households to make short-term, situational adjustments to their food-related routines in response to daily challenges or immediate

disruptions. These adjustments may include substituting unavailable ingredients, modifying recipes to accommodate what is on hand, or creatively using ingredients to avoid waste. For instance, meal mutability—the capacity to adapt recipes by replacing or omitting ingredients, tools, and preparation techniques—has been shown to align food preparation with the resources available in a household (Pickering and Reynolds, 2023). Similarly, Cooper et al. (2023) introduced the concept of “Use-up Days” as an intervention for flexible meal creation, where households are encouraged to prepare meals using a base ingredient, a vegetable, a protein, and seasonings. This approach stimulated households to be more creative and flexible in creating a meal by simplifying the meal-building process. It also encouraged them to consider fruit as a main ingredient in a dinner meal, which is often not considered in many countries, including the Netherlands (Dubbeldam, 2020). By reducing dependence on rigid recipes, these strategies encourage flexibility in cooking and support waste reduction by utilising perishable items before they spoil.

In addition to recipe adjustments, short-term changes in shopping behaviours also contribute to flexibility. Studies have shown that purchasing smaller quantities, shopping more frequently (Heidenström and Hebrok, 2022), or opting for frozen alternatives (Schanes et al., 2018) can help households prevent over-purchasing and reduce waste. For example, shopping more in the frozen food aisles not only offers items with an extended shelf life but also provides a practical alternative for preserving nutritional value and reducing spoilage compared to the items' fresh counterparts (Janssen et al., 2017). Such behaviours are particularly relevant in contexts where food availability or household needs fluctuate, as they enable households to adapt without significant disruption to their consumption routines.

2.2. Social and material dimensions of adaptable consumption

The social context of food practices also plays a critical role in shaping household behaviours and their contribution to food waste (Warde, 2016). Social norms surrounding food freshness, abundance, and variety often result in over-purchasing, which in turn leads to food waste and can hinder adaptable and flexible behavioural adoption (Stangherlin, 2018). These norms are embedded in cultural expectations and are further reinforced by external influences such as marketing campaigns, retail strategies, and societal perceptions of ‘perfect’ food (Evans, 2014; Porpino et al., 2016). For example, advertisements promoting abundance as a symbol of prosperity may encourage consumers to buy more than needed, while the rejection of aesthetically imperfect produce by retailers contributes to the normalisation of waste at both individual and systems levels. However, reframing these norms to emphasise sufficiency—buying just enough—and the acceptance of suboptimal foods, such as blemished or misshapen produce, can reduce food waste (Zhang, 2024). Educational campaigns and awareness-raising initiatives, such as those highlighting the environmental and economic benefits of choosing ‘ugly’ fruits and vegetables, have been successful in challenging ingrained consumer biases and encouraging more sustainable behaviours (Aschemann-Witzel et al., 2015). However, research also indicates that campaigns alone are often not enough to change food waste behaviours, rather multiple strategies are needed that address the various social and cultural dimensions influencing food waste producing behaviours (Cappellini and Parsons, 2012; Richetin et al., 2012; Watson and Meah, 2012).

Material infrastructure, such as storage facilities, preservation tools, and kitchen design influence how households manage, store, and utilise food (Evans, 2014). For instance, large refrigerators and freezers affect not only storage practices of households but also shopping and cooking habits, such as buying in bulk and saving large quantities of leftovers. On the other hand, households with limited storage space or inadequate

preservation methods may struggle to manage food effectively, leading to increased spoilage (Evans, 2014). The ease of acquiring food due to the high number of retailers, particularly in cities (Gojard and Véron, 2018), the prevalence of promotions and the occurrence of bulk packaging encourage over-purchasing, further exacerbating waste when excess food goes unused (Graham-Rowe et al., 2015). Research suggests that visibility-enhancing storage solutions, such as transparent containers and well-organised shelving, can reduce waste by improving inventory management and preventing items from being forgotten or overlooked (Farr-Wharton et al., 2014).

2.3. Socio-demographic factors of adaptable consumption

The broader socio-demographic factors of households play a critical role in shaping adaptable consumption practices and their relationship to food waste (Schanes et al., 2018; Stangherlin, 2018). Flexibility in employment, as discussed by Dixon et al. (2014), has significantly altered eating habits and food choices. The rise of flexible and unpredictable work schedules has disrupted traditional synchronised meal-time routines, leading to more irregular eating and provisioning patterns. These changes often increase reliance on convenience foods and unplanned or ad-lib eating and purchasing moments, behaviours that are associated with a higher likelihood of food waste (Dixon et al., 2014; Schanes et al., 2018). Explicitly supporting the need for the “just-in-time” nature of modern life has the potential to counter these wasteful practices. For instance, van Herpen and Jaegers (2022) show that consumers are willing to switch to buying frozen bread as an alternative to fresh, especially when faced with reduced fresh bread options when shopping late in the day, a switch that supports waste reduction efforts.

Household composition also plays a pivotal role in determining food waste behaviours. Households with children are particularly susceptible to higher levels of food waste (van Dooren and Mensink, 2018; van Geffen et al., 2020; Visschers et al., 2016). Parents often face challenges in predicting children’s consumption patterns which can lead to over-preparation or discarding uneaten meals. For instance, young children’s preferences and appetites change frequently (Evans, 2011; Visschers et al., 2016), while older children might make last-minute decisions to eat out or bring friends home (Visschers et al., 2016), leading to poor portion management. Children may also be involved in different types of activities, like sports or music lessons, that disrupt meal plans (Evans, 2014). Additionally, feelings of guilt associated with serving leftovers to children, combined with the societal expectation of being a “good provider,” further exacerbate food waste in family households (van Geffen et al., 2020; Visschers et al., 2016). These underscore the importance of developing interventions tailored to specific household compositions, particularly for families with children.

2.4. Reconfiguring household food practices for adaptable consumption

Food-related routines often become automated and are carried out with minimal cognitive effort, reinforcing wasteful practices (Evans, 2014; Jackson, 2005). These routines are often socially learned, passed down (e.g., parents teaching provisioning techniques to their children), and extend beyond individual behaviours to shape household behaviours (e.g., weekly shopping routines) (Warde, 2016). Because food waste behaviours are often unconscious, they emerge as a consequence of how daily routines are structured (Warde, 2016). According to Evans (2014), understanding how food waste-producing practices are embedded, socially shaped, and routinised within households is essential to shift toward food-saving practices. Yet reconfiguring food practices involves the deliberate disruption of established routines and the introduction of new materials (e.g., interventions), skills, and/or meanings to encourage behaviours that reduce food waste (Reckwitz, 2002). Such reconfigurations require households to adopt new ways of thinking about food planning, preparation, and storage.

Schuster et al. (2022) argue that meal boxes have disrupted

traditional consumption practices by substituting individual decision-making and culinary skills with pre-selected recipes, pre-portioned ingredients, and detailed instructions. While meal boxes have the potential to enhance adaptability by allowing households to adjust to changing circumstances, such as switching meal options based on seasonal or locally available produce, they may simultaneously constrain flexibility due to their reliance on fixed recipes and pre-determined meal plans (Heidenström and Hebrok, 2022). Similarly, the rise of online grocery shopping has disrupted food provisioning from in-person selection to a digital process, reducing spontaneous buying, altering social aspects of shopping, and enabling home delivery, which can affect meal planning, inventory management, and food waste practices (Heidenström and Hebrok, 2022). Online grocery shopping allows consumers to be physically close to their household food inventory, such as what is in their fridges, freezers, and cupboards, while making purchasing decisions. This proximity allows them to check what they already have at home, helping to avoid over-purchasing and better aligning their shopping with immediate and long-term needs. However, Ilyuk (2018) and Ananda et al. (2023) found that the convenience and reduced effort needed when making online grocery purchases reduce consumers’ psychological ownership—responsibility for purchases and negative affect toward parting with purchases—over the food items purchased. This in turn, increases the likelihood that consumers throw away food items purchased online. Also, the quality of fresh products when purchased online cannot be assessed sensorially, which might lead to dissatisfaction with delivered goods, which can increase the risk of food being discarded once it arrives at the home (Abbott, 1999; Park et al., 2021; Schifferstein et al., 2019).

Beyond these provisioning interventions, reconfiguring food practices involves fostering new skills associated with food management. Ability and knowledge gaps, particularly regarding food safety and label interpretation, contribute significantly to waste behaviours. Studies by Watson and Meah (2012) and Wilson et al. (2017) show that individuals frequently discard edible food due to misunderstandings of “use-by” and “best-before” labels, which are often misinterpreted as indicators of food safety rather than quality. This lack of ability to assess food freshness and safety independently of labels reflects a gap in self-efficacy, or the belief in one’s ability to manage food effectively (Bandura, 1986). Therefore, increasing food-related knowledge and skills can empower and support individuals in making informed consumption and disposal decisions and reducing unnecessary waste. Cooper et al. (2023) and Pickering and Reynolds (2023) exemplify this by showing that enhanced cooking skills support reducing food waste by improving inventory management and the use of unused ingredients. Similarly Stefan et al. (2013) show that improving planning skills can increase the efficient use of resources, thereby reducing waste.

3. Methods

This study employs a qualitative, designerly approach to explore adaptable consumption in households with children in the Netherlands. Three materials were specifically designed for this study: (1) a cultural probe booklet, (2) a visual scenario of adaptable consumption and (3) seven product or service innovation concepts for adaptable consumption. The cultural probe was presented at the start of the study and invited participants to actively engage with the topic of the study (Gaver et al., 1999). Subsequently, semi-structured interviews were conducted, in which the scenario and the innovation concepts were presented, portraying potential ways to reduce food waste (Fig. 1). The use of these materials, next to the interviews, aimed to elicit information not only on the attitudes, behaviours, and routines of households but also specifically on the physical household artefacts and service set-ups that make for people’s food waste context, thereby generating rich, qualitative data encompassing both the explicit and unspoken aspects of their experiences (Sanders and Stappers, 2012). All the materials were available in Dutch and English to accommodate the language preferences of the

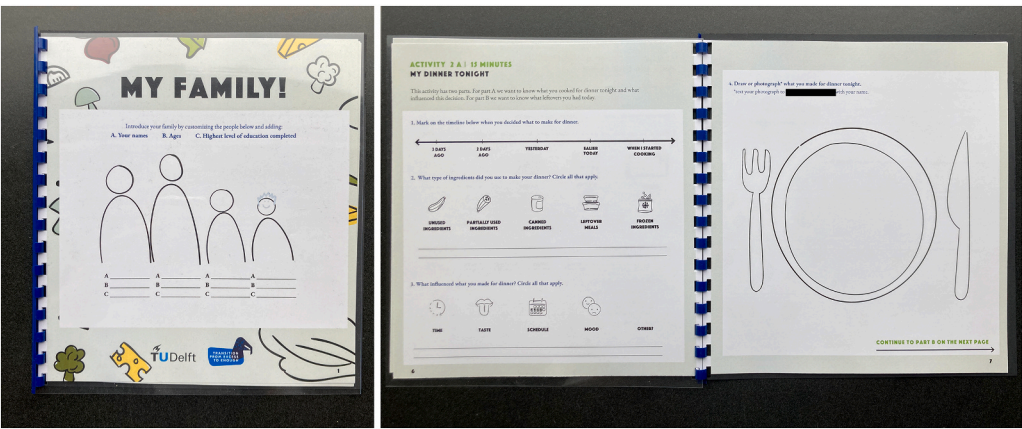


Fig. 1. Cover page (left) and part of Activity 2 (right) from the cultural probe booklet provided to each participating household.

Table 1
Cultural probe activities and theories behind them.

CULTURAL PROBE ACTIVITIES	POSITION IN THE PATH OF EXPRESSION	TYPE OF ‘DO, SAY, MAKE’ ACTIVITY
Activity 1 collected background information about the households, including names, ages, highest level of completed education, weekly grocery spending, distribution of grocery purchases across different outlets (e.g., in-store, online, market), and responses on a 5-point Likert scale regarding the frequency of engaging in flexible behaviours (e.g., cooking seasonally, using frozen ingredients).	Past to Present	Do
Activities 2 and 3, which were identical, asked families to draw or photograph their dinner and specify the time they decided on the meal. Participants noted the types of ingredients used (uncut whole, partially used, canned, leftover meals, and frozen), the factors influencing their decision (time, taste, schedule, mood, and other), and any preparation, cooking, or plate waste, along with how they handled these.	Past to Future	Do
Activity 4 asked households to prepare either a soup or curry dish for dinner, using two of the four provided ingredients. Participants were asked to draw or photograph their meal and specify which of the ingredients (chickpeas, bell peppers, apples, and bulgur) they used. They also described their likes, dislikes, and neutral experiences regarding the cooking activity.	Present	Make
Activity 5 was similar to Activity 4, except that it asked households to prepare any dish for dinner as long as it incorporated two of the four provided ingredients.	Present	Make

participants.

The materials in the study use the Path of Expression to guide participants through the research activities (Sanders and Stappers, 2012). The Path of Expression, based on psychological theory about memory and creativity, refers to the process of steering participants through a process of observing present experiences, recalling and reflecting on good and bad memories of the past, and imagining their hopes and dreams for the future (Sanders and Stappers, 2012). In design research, guiding participants through this pathway is supported by ‘Do, Say, Make’ activities (Sanders and Stappers, 2012). ‘Do activities’ encourage participants to express themselves through actions and making; ‘Say activities’ involve verbal expression; and ‘Make activities’ involve creating something to express themselves. In this study, ‘Do and Make activities’ were used in the cultural probe, whereas ‘Say and Do activities’ were primarily used in the interview—see Table 1 and Table S2 in the Supplementary File.

Additionally, participants were provided with four different food items to cook with during two of the activities described in the booklet (see Table 2). Including the food items introduced an additional unexpected event that participants would have to respond to in their consumption practice. The food items included 3 bell peppers and 4 apples (among the most wasted foods in The Netherlands), a bag of bulgur (chosen for its shelf life and lower familiarity as a grain in The Netherlands), and a pouch of chickpeas (selected for their versatility and shelf life) (van Dooren and Knüppe, 2020; van Dooren and Mensink, 2018).

3.1. Cultural probes

Cultural probes are a prominent method in design research and are particularly effective in settings where the presence of researchers might influence participant behaviour (Sanders and Stappers, 2008). A cultural probe often consists of a booklet with a number of relatively simple tasks that may involve practical activities or reporting opinions, emotions, and behaviours. One of the aims is to prepare and sensitise the participants to the topic of the study, so that they can optimally engage with the topic (Mattelmäki, 2006). The cultural probe is delivered to the participants’ home before the start of data collection, so that participants can register their behaviours, form their opinions, and reflect on these, without the interference of the researchers (Sanders and Stappers, 2008). It allows participants to generate their own visual and narrative data, in their own context, thus offering researchers rich, context-specific insights without the intrusiveness of traditional ethnographic methods that require prolonged researcher immersion.

Cultural probe studies are not intended to produce conclusive results; rather, they aim to provide a rich understanding and inspire design opportunities rooted in actual user experiences and needs (Sanders and Stappers, 2012). Cultural probes must be tailored to reflect the specific context of inquiry, ensuring that the probes not only gather relevant and rich data but also resonate with the participants’ everyday experiences and the unique challenges of the research context. As cultural probes are developed for a specific context, they usually cannot be used in a different study that has a different goal. While it is essential that each probe is custom-made (Mattelmäki, 2005), the design of cultural probes

Table 2
Activities and materials of the study. The process is repeated for each participant.

	PHASE 1	PHASE 2	PHASE 3
RESEARCH ACTIVITIES	<i>Day 1: Introduction</i> <ul style="list-style-type: none">• Researcher introduces participant to the research at the participant's home.• Researcher explains the booklet and its activities and takes photos of the participant's domestic food spaces.	<i>Days 2–8: Booklet Activities</i> <ul style="list-style-type: none">• Do and Make activities.• Participant completes the booklet activities in their home, at a time of their choosing. The researcher is not present.• Interview preparation:<ul style="list-style-type: none">– 48 h before the interview participant sends photos of completed activities to the researcher.– Researcher reviews the completed activities.	<i>Day 9: Interview</i> <ul style="list-style-type: none">• Do and Say activities.• Audio-recorded interview at participant's home.• Part 1 of interview goes through the booklet.• Part 2 of the interview goes through the behaviours of adaptable consumption (comic strip).• Part 3 of the interview goes through the innovation concepts.
MATERIALS	<ul style="list-style-type: none">• Booklet of 5 activities to be completed by participant.• Four different food items for the participant to use during activities 4 and 5.	<ul style="list-style-type: none">• Booklet of 5 activities.	<ul style="list-style-type: none">• Completed booklet of 5 activities.• User scenario notated by participant during the interview.• Overview of 7 innovation concepts notated by participant during the interview.
RESEARCHER CONTACT WITH PARTICIPANT	<ul style="list-style-type: none">• 30 min for the introductory meeting.	<ul style="list-style-type: none">• Minimal contact, only to clarify questions and send completed activities.	<ul style="list-style-type: none">• 1 h for the interview.

adheres to several guidelines—such as aligning tasks with research questions while also ensuring they are sufficiently open-ended to encourage creative and broad-ranging responses from participants and facilitating self-documentation through methods like photography or diary entries. However, this context specificity also limits the generalisability of cultural probe studies. Additionally, performing and reporting on the activities and analysing the rich information gathered in the booklets are labour-intensive both for the participant and researcher, often resulting in smaller sample sizes (Sleeswijk Visser et al., 2005).

Nevertheless, given that the current literature lacks insights into opportunities to support households in adopting adaptable consumption practices to reduce food waste, the cultural probe method is well-suited to identify such opportunities. It supports participants (i.e., households) in exploring and communicating their ideas about how they want to live, work, and be in the future (Sanders and Stappers, 2012), offering a contextual, nuanced, and opportunity-revealing understanding of participants' contexts. Cultural probes methodology has been utilised across food-related research to explore solo dining experiences and food choices (Bocanegra et al., 2022), uncover drivers of bread consumption (Pantidi et al., 2017), encourage sustainable eating habits (Cho et al., 2021), and investigate motivations and barriers to reducing food waste (de Bruin et al., 2019).

The cultural probe used in the present study was a small booklet of 5 activities, and each household was provided with its own. The booklet was designed to be playful, aesthetically pleasing and provoking, with minimal text. Each activity was designed to take between 5 and 20 min. The activities focused on dinnertime, which is the meal most often consumed together as a family (Cooper et al., 2023). The activities were selected and designed to capture a holistic view of households' food-related behaviours and routines related to adaptable consumption and food waste, while also respecting participants' time by balancing depth and ease in each task to make participation manageable. Therefore, the five activities, as described in Table 1, ask participants to photograph, draw, circle, and jot-note experiences rather than write paragraphs of text. The filled-in booklets informed and were used during the semi-structured interviews (Mattelmäki, 2005). See Fig. 1 for an impression of the style and quality of the booklet, and see the Supplementary File for all the booklet pages.

3.2. User scenarios

The second material designed for the present study was a visualised user scenario (i.e., comic strip) depicting a household engaging in a proposed practice of Adaptable Consumption. User scenarios are

valuable methodologies in design as they enable the exploration, communication, and evaluation of future possibilities in participatory research. User scenarios, which can take forms such as written narratives or comic strips, are rich descriptions of how users interact with a design proposal, helping to identify user needs, contextual challenges, and areas for refinement (de Bont et al., 2013). Comic strips, in particular, use sequential visual storytelling to depict user behaviour, emotions, and interactions in an engaging and accessible way, fostering empathy and understanding among users (Tversky, 2018). Scenarios, if validated by the users, provide a realistic and concrete use context which users themselves utilise to evaluate design concepts.

The behaviours depicted in the present scenario were the outcome of a study conducted as part of a research project called “From Excess To Enough” (FETE), a collaboration involving three Dutch universities and eight organisations within the food system (see Goss et al., 2023, 2025). As a consortium, FETE is interested in how they can support households in realigning the values of food safety, food quality, and sustainability to foster the transition toward less food waste. The behaviours depicted in the user scenario include 1) mixing and matching ingredients and flavours, 2) assessing food quality with the senses, 3) adjusting recipes for different portions, 4) thinking on a meal level, 5) adjusting food purchasing based on how much food they waste, and 6) storing leftovers effectively to integrate them into meals (Fig. 2). Throughout the scenario (i.e., comic strip), different innovations supported the household in engaging in these behaviours. The scenario was printed on an A3 sheet of paper for each household (see Fig. 2) and presented during the interview.

3.3. Innovation concepts

The third material used in this study was an overview of seven innovation concepts (see Fig. 3). Each of the innovations was designed to stimulate specific adaptable behaviours that could help reduce food waste. Innovation concept drawings complement scenario methods by making the concepts depicted in the scenarios more tangible and discussable with participants (van den Hende, 2010). Each concept drawing was accompanied by 2–4 lines of text explaining the operation of the innovation. These concepts were printed on an A3 sheet of paper for each household and presented during the interviews. The seven innovations were: 1) Collection Insight App, 2) Freezer Storage, 3) Use Me Later Tools, 4) Frozen Offering, 5) New Sensory-Driven Food Labels, 6) Ingredientless Recipes, and 7) Surprise ‘Incomplete’ Boxes. For a full account of the development of these innovations, see Goss et al. (2023); Goss et al. (2025).

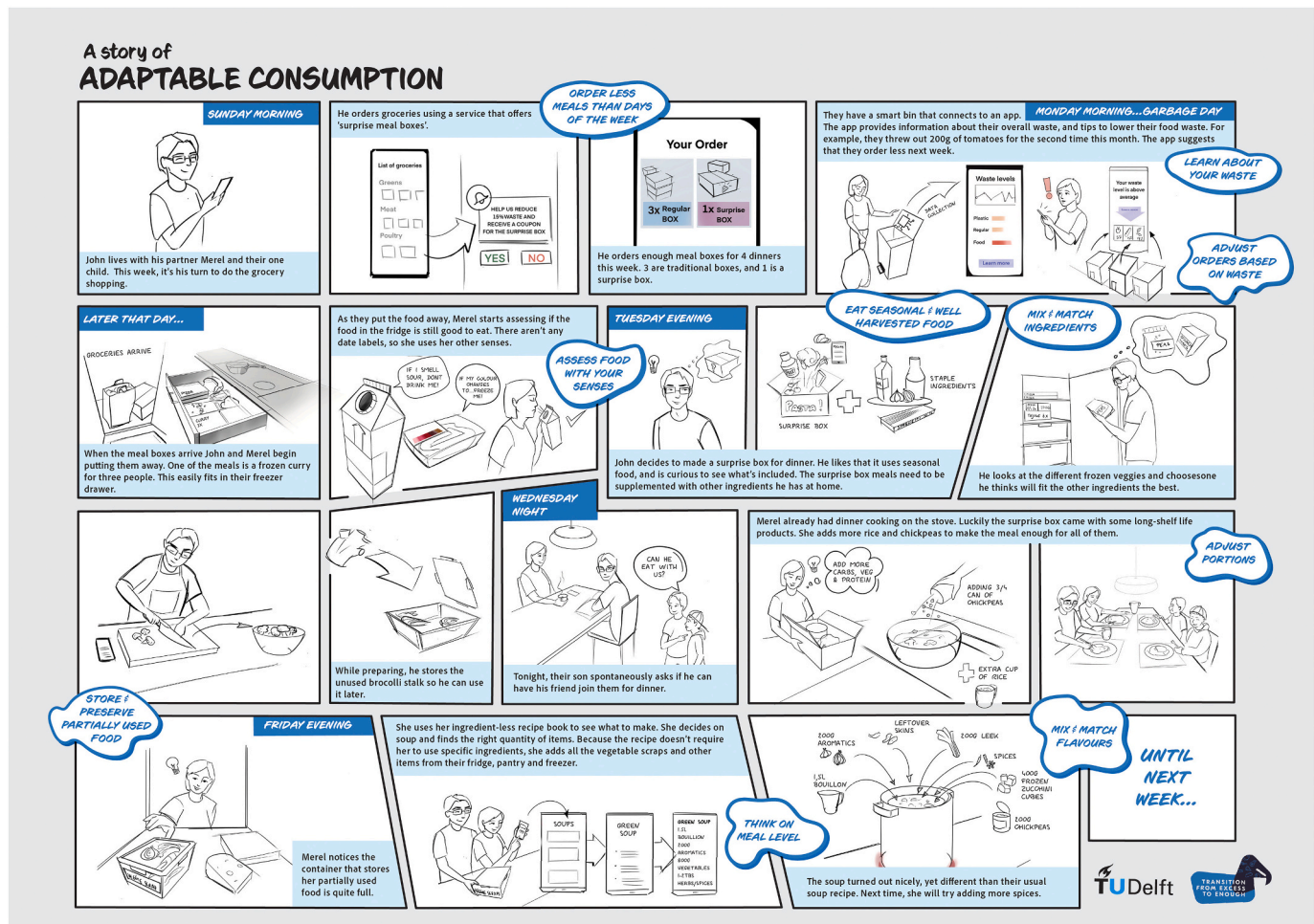


Fig. 2. User scenario depicting a household engaging in Adaptable Consumption. The drawings are by Maria Sofia.

3.4. Participants

Data were collected from 43 participants, comprising of 20 adults and 23 children, across 11 different households living in the Netherlands with at least one child under 18 years old. Following Cooper et al. (2023), households with children were chosen because they have the highest absolute level of household food waste, also in the Netherlands (van Dooren and Knüppe, 2020). Participants were recruited through the networks of the first author and the research assistants. During recruitment, attention was paid to diversity across participating households, such as in the number of children, age(s) of children, geographical location within The Netherlands, and interest in sustainability-related behaviours.

There were 2 households with one child, 6 households with two children, and 3 households with three children. The children's ages ranged from 3 to 15 years old. The highest level of education among the adults varied: 3 had PhD degrees, 6 had master's degrees, 6 had bachelor's degrees, 4 had college degrees, and 1 had vocational training. Therefore, the education level of the participants was higher than the national average in the Netherlands (CBS, 2024). See Table S1 in the Supplementary File for the participant demographics.

The first author developed the research materials, recruited most of the participants (8 out of 11 households), and analysed the data. To reduce bias, the first author did not collect any data, and the research assistants did not collect data from households they recruited or had previous contact with during recruitment. Ultimately, each research assistant collected and transcribed data from 3 to 5 households. Participants were informed about the purpose and structure of the study

and signed an informed consent prior to data collection. Participants spent 1.5 h with the research assistant across the 9-day data collection period (see Table 2). Each household was compensated with a €100 gift voucher and a food waste reduction tool package from the Netherlands National Nutrition Centre. Participants had the option to participate in English or Dutch.

3.5. Data collection

Data collection occurred between February and March 2024 by three research assistants who gathered and transcribed data from both the cultural probes and interviews. The research with the participants was set-up in three phases: (1) introduction and start of the study, (2) booklet activities, and (3) semi-structured interviews (Table 2).

3.5.1. Introduction session

The first interaction with the participants was through e-mail, inviting them to participate in the study. When people agreed to participate, a 30-min onboarding session conducted in participants' homes was planned. During this session, the research assistant distributed the cultural probe booklet, provided several products to be used in the cooking assignments and introduced the different activities. Additionally, food-related spaces (e.g., kitchen and refrigerator) were photographed to support contextualising the data (Gojard and Véron, 2018; Watson and Meah, 2012). At the introductory session, it was explicitly communicated verbally and in the informed consent that participant anonymity was guaranteed during data collection, analysis, and reporting.

INNOVATIONS OF ADAPTABLE CONSUMPTION

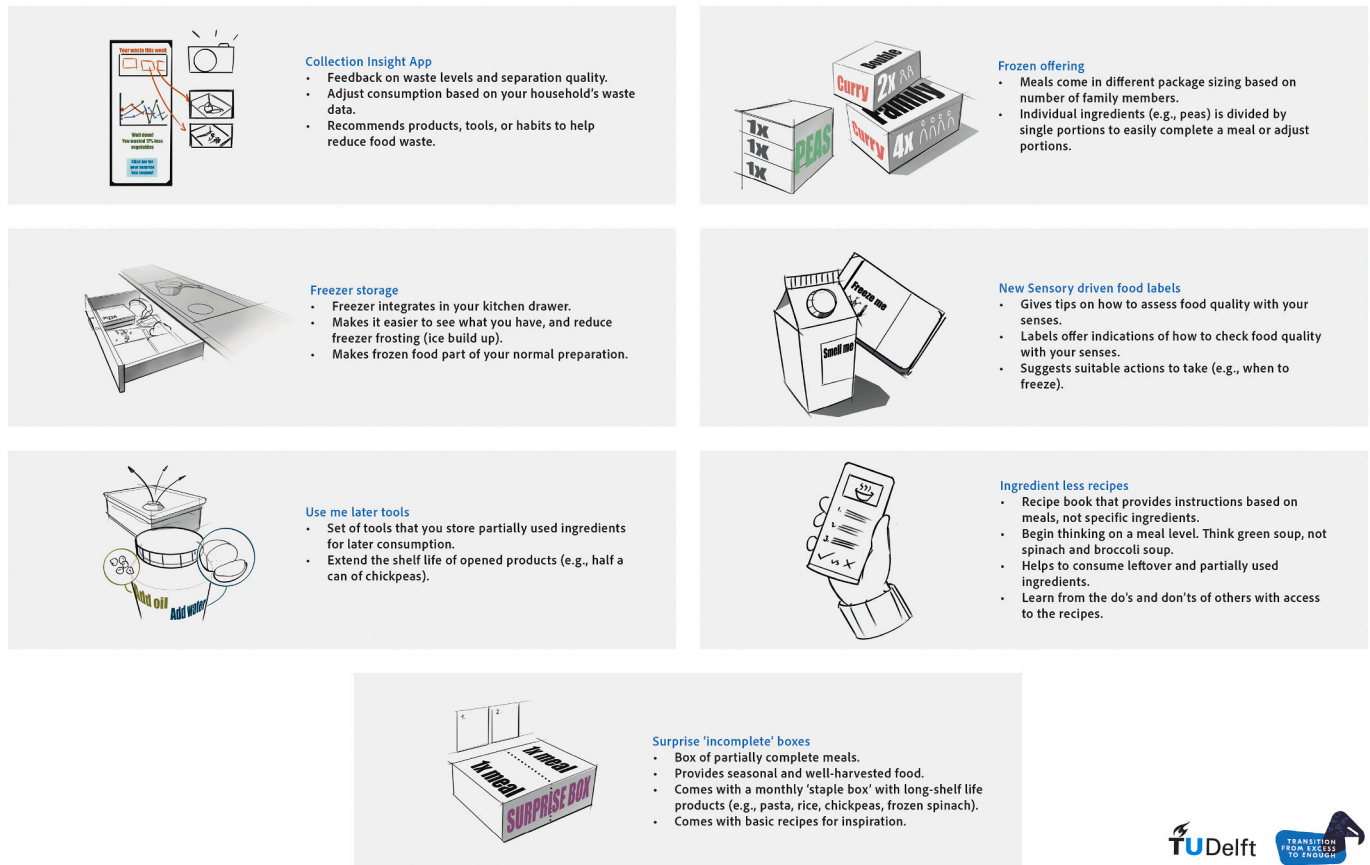


Fig. 3. Overview of the innovations designed to support Adaptable Consumption. The drawings are by Maria Sofia.

3.5.2. Filling out the cultural probe booklet

Over seven consecutive days, participants were asked to complete their booklet and perform five activities in their homes without the researcher present. The activities ranged from indicating what they had for dinner and the way they handled their leftovers and waste (e.g., activities 2 and 3), to cooking activities that required participants to integrate the ingredients provided to them and reflect on this experience (e.g., activities 4 and 5). Each activity explained, in text form, what the participant should do and what information needed to be recorded in the booklet. An overview of the activities is shown in Table 1, and each activity is detailed in the booklet photographs in the Supplementary File.

3.5.3. Interviews

1-h interviews with participants were scheduled at their homes within 7 days of completing the booklet activities. When more than one adult from the household participated in the interview, both adults answered the interview questions together. In preparation for the interviews, the participants were instructed to send photographs of their completed activities to their researcher. The interview format was semi-structured and divided into three parts, each with supporting material (see Table S2 in the Supplementary File for the interview setup).

The first part of the interview focused on the booklet results, with the photographs and text from the activities serving as supporting material. The second part focused on exploring and discussing behaviours of adaptable consumption toward less food waste. It used the 1-page user scenario depicting a consumer going through their week while engaging in the behaviours of Adaptable Consumption as supporting material (see Fig. 2). Participants evaluated the likelihood of adopting the behaviours

and provided reasoning for their assessments. Coloured dot stickers were used to record their responses, with each colour representing different levels of likelihood and readiness of adoption (refer to Table S2 in the Supplementary File for the interview questions). The third part of the interview focused on evaluating the innovations that supported adaptable consumption and used the 1-page overview of the 7 innovations (see Fig. 3). The innovations presented did not exist and were only presented through drawings. Participants assessed the likelihood of incorporating these innovations into their daily lives and explained their reasoning. Similar to the above, coloured dot stickers were used to indicate preferences, with each colour representing a specific level of likelihood of adoption (refer to Table S2 in the Supplementary File for the interview questions).

3.6. Data analysis

All 11 households completed the cultural probe activities and participated in the interview. The data from the cultural probes and interviews were collected, transcribed, and translated into English as necessary. All collected data (Table 3) were entered into Atlas.ti, a qualitative analysis software. Thematic analysis, a common practice in qualitative research methods and previously used in studies on food waste (Filimonau et al., 2022), was undertaken following Braun and Clarke's (2006) guidelines. Specifically, an inductive thematic approach was chosen due to its suitability for exploratory studies that aim to identify patterns, themes, and meanings within the data, especially when relationships and structures are not predetermined.

Following Braun and Clarke (2006), the first step of analysis involved thoroughly reviewing the entire data set, including the transcripts,

Table 3

Data collected and analysed in this study.

DATA SOURCE	DESCRIPTION	REASON OF COLLECTION
Cultural probe activities	11 complete booklets containing 5 activities.	Insights into actual food consumption behaviour.
Interview transcripts	11 semi-structured individual interviews with each participating family (audio recorded and transcribed).	Individual and in-depth reflections on adaptable consumption toward less food waste.
Domestic photos	139 photographs of domestic food-related spaces within each participant's home (e.g., kitchen, inside the fridge and freezer, garbage).	Support contextualising the data from the booklets and interviews.
User scenario with dot stickers	11 printed visualised user scenarios with different coloured dots indicating preferences.	Support participants in reflecting on their judgments of adaptable consumption.
Innovation overview with dot stickers	11 printed innovation overviews with different coloured dot indicating preferences.	Support participants in reflecting on their judgments of innovations that support adaptable consumption.

booklet activities, domestic photographs, and notated user scenarios and innovation overviews. Second, each data extract (e.g., quotes, photograph) was coded if it suggested adaptable or flexible behaviours related to food waste. This resulted in 25 codes such as “assessing food quality with the senses,” “changes to routines,” and “catering meals to available ingredients”. Third, the codes were organised into themes, ensuring that the themes accurately represented both the coded extracts and the data set as a whole. This step also involved examining the data extracts to identify them as barriers or opportunities for performing adaptable consumption behaviours toward reducing food waste within its theme.

During analysis, preliminary themes and their corresponding codes and supportive extracts (e.g., quotes) were independently discussed with the second and fourth authors. Following these reviews, the first author completed the rest of the analysis. The analytical process is depicted in Fig. 4. The final themes induced by the thematic analysis are presented in Fig. 5.

4. Findings and discussion

In response to the pressing challenge of food waste, this study investigated how Dutch households engage in adaptable consumption to identify opportunities to foster both flexible and adaptive waste-reducing behaviours and practices. In this section, the findings, limitations, and directions for future research are discussed.

4.1. Opportunities for adaptable consumption toward waste reduction

Based on the thematic analysis, five themes were identified in the data that represent opportunities for supporting households in adopting adaptable consumption toward waste-reducing behaviours. These include 1) supporting flexible meal moments, 2) reclaiming the edibility of food, 3) reintegrating food into routines, 4) integrating feedback loops, and 5) playing into life-changing moments (Fig. 5). Each theme is discussed below with representative quotes from the interview transcripts to add validity to the study's findings.

4.1.1. Supporting flexible meal moments

Participants indicated that experimentation and exploration in meal preparation occurred during less constrained times, such as weekends and holidays, when they felt they had more mental space. They also indicated that meal choices were shaped by the anticipated time available for preparation, eating, and cleaning. This finding supports Boulet et al. (2021) and Watson and Meah (2012), who argue that time constraints are a finite and critical factor influencing meal planning and the resulting food waste. For instance, one participant noted:

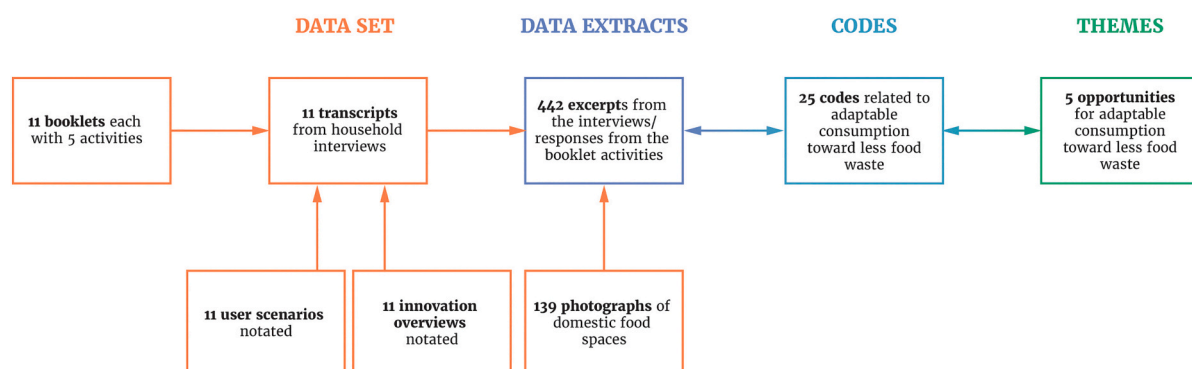
“In the holidays, I can experiment more because then I have more peace of mind. In the weekdays, I am being lived, and then I quickly go after the standard meals.” – Household 12.

This flexibility can support households in repurposing leftovers or using near-expiring ingredients that may not fit into weekday routines.

Participants exhibited diverse approaches to meal planning, balancing the need for predictability with moments of change. Some organised meals around weekly grocery shopping trips and assigned specific meals to days, while others shopped weekly but determined daily meals based on the freshness of ingredients and family preferences. Many participants highlighted the appeal of straightforward, family-approved recipes that were quick to prepare, ensuring the preparation efforts were justified. However, they also expressed a desire to break the monotony of routine meals, seeking ways to integrate variety without overhauling their entire meal plan. As one participant noted:

“If I’ve been working all day, I come home, then very quickly I make the same things, and I always think that’s too bad. Of course, things can be similar and that’s fine but if it’s the same food, I find it boring.” – Household 10.

“During COVID we ordered meal boxes. What appealed to me was the fact that they put a lot of thought into creating good flavour combinations. It allowed for much more variety and self-discovery in cooking. When left to our own devices, we fall back on standard combinations like cauliflower, potatoes, and meat or vegetarian options, but then we miss out on the exciting combinations.” – Household 6.

**Fig. 4.** Overview of the thematic analysis process undertaken in this study.

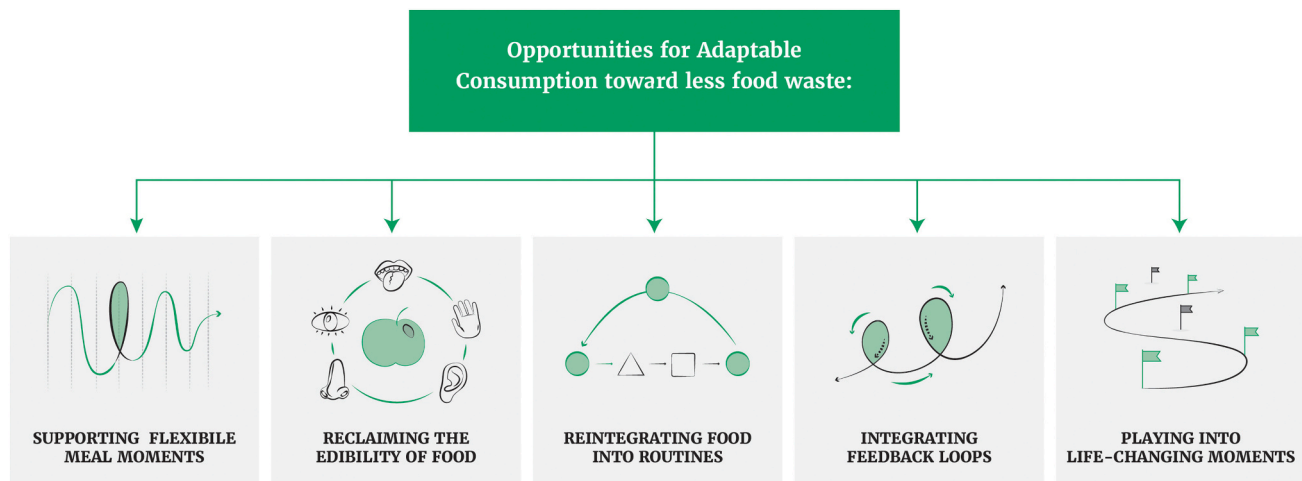


Fig. 5. Themes induced from the data that present opportunities for supporting adaptable consumption toward less food waste.

By incorporating flexible moments, households can introduce new flavours and recipes without compromising their established routines. Current research has explored differences between online grocery shopping and in-store shopping (Zhang and Qi, 2024) and differences between preparing using meal boxes and conventional ‘loose’ shopping as they relate to food waste generation (Schuster et al., 2022). However, examining the impact of controlled or fixed weekly meal planning versus flexible day-to-day choices on food waste outcomes could provide further insights into the balance of routine and flexibility in household consumption.

Research shows that introducing novelty into consumption reduces decision fatigue by providing new options without the burden of constant choice (Warde, 2016). Meanwhile, reliance on familiar recipes and ingredients helps households manage daily pressures through established routines (Torkkeli et al., 2021). In the present study, participant routines were intentionally disrupted by providing additional ingredients and requesting that households prepare specific meals using these ingredients. While many participants appreciated the change to their routine, they reported that these extra ingredients did not alter their provisioning habits. Households continued with their regular grocery shopping, adding the study-provided ingredients to their meals. This finding suggests that introducing flexibility should be carefully managed to avoid inadvertently generating waste, as spontaneous routine disruptions could cause current food to displace existing ingredients (Evans, 2014). In line with this, participants in the study responded positively to the “Incomplete surprise boxes” and “Ingredientless recipes” innovations because they would offer meal structure while allowing for customisation, thereby introducing novelty without departing too far from comfort zones. This direction supports research by Cooper et al. (2023) and Pickering and Reynolds (2023), who suggest that interventions combining structure and flexibility can lead to more efficient resource use and reduced food waste. Nevertheless, the participant’s willingness to adopt flexibility-supporting interventions is tempered by the strength of their existing routines and confidence in the kitchen. For instance, participants reflected,

“I’m in favour of flexibility, but not within a meal. Most of the time we stick to dishes and recipes we know are tasty.” – Household 11.

“I had to laugh really hard when we had to cook a curry or soup for activity 4. Because you immediately see the difference between me and [my partner]. I just have a weekly menu, so I found this a hassle because I’m not such a good cook. So we did it on the weekends and [my partner] went wild.” – Household 10.

In everyday practice, participants employed various strategies to adapt their meals, such as using frozen or long-shelf-life products,

repurposing leftovers, and preparing meals in stages to meet family preferences (e.g., separating vegetarian and non-vegetarian meal variations). This adaptability allowed them to adjust portion sizes and ingredient use to match family needs, supporting waste reduction by preventing the preparation of excess or unwanted food.

The findings of this opportunity indicate that balancing flexibility with routine is crucial for maintaining sustainable food practices without overwhelming households. By introducing adaptable and flexible moments within their routines, households can explore new foods and recipes without compromising sustainability or family goals, ensuring that food provisioning remains efficient and waste-conscious. For instance, interventions encouraging households to try one new recipe each week alongside familiar meals can help them explore new foods and add variety to their routine. By explicitly integrating food items consumers already have at home within these new weekly recipes can also support waste reducing behaviours.

4.1.2. Reclaiming the edibility of food

Participants in this study demonstrated a flexible approach to assessing food usability, often treating expiration dates as approximate rather than definitive indicators of food safety. Many participants described using sensory cues—such as smell, appearance, and texture—to determine whether the food was still edible, even when it had technically surpassed its labelled expiration date. This sensory-based approach reflects a growing trend, as seen with the “Look-Smell-Taste” labelling initiative by Too Good To Go, which encourages consumers to use their senses before discarding products (Too Good To Go, 2022). One participant explained,

“I don’t really believe in expiration dates. I trust my senses more than the expiration label. You can often tell if something is still good just by giving it a sniff... while I understand the legal aspects of expiration dates, I also know that it’s not always necessary to discard food once it reaches that date.” – Household 6.

Consistent with other studies, participants did not apply sensory evaluations uniformly across all food categories (Patra et al., 2022; Watson and Meah, 2012). While they confidently used sensory checks for low-risk items, they were more cautious with high-risk foods like dairy, eggs, and meat, where perceived health risks were higher. Notably, sensory evaluations were often applied as items neared their labelled dates, but were less likely to be trusted once those dates had passed. One participant explained,

“If it is something that is a long-life product and it is approaching its date, then I [evaluate the product] by feel or sight. But I don’t use anything after the expiration date. I trust my senses when it’s approaching its sell-by

date. And a “Sensory driven food label” as you propose is also not going to convince me to use it afterwards.” – Household 7.

This selective flexibility suggests an adaptability rooted in risk management, indicating that households might benefit from support to make context-specific decisions that reduce waste without compromising safety. For partially spoiled items without date labels, participants displayed mixed approaches: some salvaged edible portions by cutting away blemishes, while others discarded whole items as they no longer met their freshness standards. As one participant remarked:

“Well, there was a small spot in the pepper that we got [from you], so I exchanged it with our own bell pepper... yours was no longer good, and I was afraid it will make us sick.” – Household 8

This behaviour aligns with broader findings in the literature, suggesting that food is often discarded not due to complete spoilage but because it no longer meets household expectations (Aschemann-Witzel et al., 2015; Evans, 2014; Schifferstein, 2024). Risk aversion plays a significant role in these decisions, as risk perceptions significantly influence consumers’ willingness to consume or discard sub-optimal food items. Tsiros and Heilman (2005) suggest that perceived health risks outweigh economic or environmental considerations, particularly as items near expiration. Educating consumers on the perishability of certain foods and promoting a moderate acceptance of sub-optimal items (such as bruised or soft produce) could foster cultural norms that support waste reduction without compromising safety.

A tension between “thrift” and “hygiene” was evident in participants’ decision-making as described by Watson and Meah (2012). While the present study found that participants raised in households with thrift-oriented values were more inclined to salvage food to minimise waste, supporting findings by Aschemann-Witzel et al. (2015), it also identified an adaptability among participants who were not raised with thrift-oriented values. This adaptability reflects a gradual shift in attitudes, as environmental awareness encourages some households to embrace thrift as a waste-reducing practice. For instance, two participants reflected these contrasting backgrounds:

“When I was a teenager at my parents’ house, I would throw away everything from the fridge that was out of date because then I thought it was bad. Now I think it’s really wasteful to just throw things away if it’s still good. [This change] happened a bit gradually now that there are more and more concerns about the climate and that you look a bit at what you can do yourself.” – Household 8.

“Judging food with my senses, I actually always have done this. I inherited it from childhood. You begin to notice which activities actually lead to less food waste.” – Household 10.

The study also highlighted a sense of agency among participants who preferred personal judgment over regulatory standards. One participant remarked,

“It’s simply a sense of agency of not being dictated by label.” – Household 4.

Watson and Meah (2012) describe date labels as technological interventions that shift responsibility for food safety away from sensory assessments to institutional guidelines, which contributes to consumer mistrust and a reliance on external standards over personal judgment. In the present study, when uncertain about food safety and edibility, some participants sought reassurance from household members or online resources, particularly for items that looked edible but raised doubts. One participant shared,

“We had mushrooms this week that were a bit brown. I said to my husband, is it still good? I really wanted to check it, so I googled it to see how you can determine if these are still OK. It said you should smell, and if they don’t smell neutral then it’s not OK. I smelled and it smelled really weird, so it wasn’t good anymore. So, something like the ‘sensory labels’

innovation with added cues would be really handy because now I’m just googling.” – Household 3.

This illustrates that consulting ‘others’ (human or non-human) can serve as a social risk mitigation strategy, providing an additional layer of reassurance and shifting the responsibility from an individual decision to a collaborative one. This behaviour reflects how households share responsibility in food-related decisions, a finding that aligns with Watson and Meah’s (2012) observations on the social dimensions of domestic food management. It suggests that such risk mitigation resources can be explicitly introduced into households as a way of navigating uncertainty around food usability, supplementing traditional sensory evaluations.

This opportunity suggests that increasing a household’s adaptability in assessing food quality and confidence in sensory-based evaluations, supporting decision-making, and communicating about perceived risks can prevent premature disposal of food items and promote the consumption of sub-optimal foods, thereby reducing waste. While this approach does not imply encouraging the consumption of food with a high risk of illness (e.g., meat past its expiry date), it can help consumers adapt to foods changing textures with diminished quality, which often remain safe to consume but are otherwise discarded.

4.1.3. Reintegrating food into routines

Participants frequently employed various strategies to reintegrate food into their routines with the dual goals of feeding the household and using existing food inventory. A common method was freezing leftovers and ingredients to extend their shelf life, aligning with literature highlighting freezing as an effective waste reduction strategy (Nikolaus et al., 2018; Schanes et al., 2018; van Dooren and Knüppe, 2020). However, a recurring challenge identified by participants was the tendency to forget about frozen items once stored, a limitation also noted by O’Neill et al. (2022). Without explicit plans for the reintegration of frozen foods into meal planning, their potential to reduce waste is often negated, as one participant reflected:

“Sometimes I freeze it when it is a whole meal. However, the risk is that if we do that, it will be in the freezer for 80 years and will never be used.” – Household 2.

This highlights the need for adaptable strategies that support the reintegration of stored items into meal routines, rather than simply relying on storage as a solution. The study also found that visibility and accessibility of stored food are crucial for waste prevention, aligning with research suggesting that easily accessible items are less likely to be forgotten (Farr-Wharton et al., 2014; Schanes et al., 2018).

Participants expressed interest in innovations in this study like the “Use-me-later-tools” for its potential support in extending the open-shelf life of items, and the convenience of storing partially used food items for later use. At the same time, there was scepticism about incorporating new storage solutions into existing habits. This finding, together with the overwhelming variety of available storage options on the market today, highlights a significant behavioural gap between recognising the benefits of more visible and organised food spaces (e.g., fridge, cupboard, and freezer) and the actual adoption of new tools intended to extend food life and reduce food waste. For instance, one participant reflected that,

“Better storage containers would be handy. Like the ‘use-me-later tools’. Now, when I have 1/2 tin of things, chickpeas or tomato sauce or so, it’s always a bit difficult to store, or it falls over in the fridge. On the other hand, often I just use the package where it comes from, so I’m not sure I would actually use it.” – Household 1.

Participants also discussed efforts to incorporate locally and seasonally sourced produce into their routines, reflecting an environmental awareness and a preference for low-carbon food options. However, participants’ experiences in the present study aligned with those

documented by Heidenström and Hebrok (2022) and O'Neill et al. (2022), who noted that while there is significant enthusiasm for local and seasonal eating, practical challenges such as availability, flexibility, and convenience can hinder the consistent integration of these practices into everyday life, and may contribute to increased waste. Participants reflected,

“We started with the vegetable and fruit box, but now we only have the fruit box because the vegetables were a bit too difficult in the winter to eat it all.” – Household 1.

These findings emphasise that sustainable procurement practices like seasonal eating require support, such as recipe suggestions and flexible preserving solutions, to help consumers adapt these practices without generating additional waste.

Another notable practice involved the intentional preparation of extra food for future meals, particularly as “meal-prep” for weekly dinners or lunches. Typically, participants saved preparation leftovers while discarding plate waste into the bin as being unfit for later consumption, a finding also found by Nikolaus et al. (2018). Participants who saved preparation leftovers typically saw this as a time-saving measure, intentionally preparing larger portions reinforcing a sense of efficiency, while others just focused on using whatever was leftover for other meals, whether their leftovers were initially planned or just the outcome of inaccurate preparation. Three participants reflected,

“I cook big portions so I don’t have to cook often during the working week.” – Household 8.

“It’s rarely that I don’t have leftovers because I cook too much. And then my husband eats it the next day at lunch.” – Household 3.

“Once a week I say, ‘Tonight is leftover day.’” – Household 2.

This perception of leftovers as functional and time-saving efforts reflects Cappellini’s (2009) findings that leftovers are often valued as both a convenience and a means to optimise household routines. Dedicating certain days for consuming leftovers, as shown by some participants in the present study, encourages routine integration of leftovers into planning and increases acceptance of leftovers within the household by reframing it to a positive ritual and family experience (Evans, 2014).

This opportunity illustrates that household strategies for reintegrating food leftovers into routines involve a complex interplay between intentions and practical constraints. The aspiration to reduce waste and embrace sustainability often confronts the realities of daily life, where time, convenience, skill, and habit play significant roles in effective adaptable and food saving behaviours.

4.1.4. Integrating feedback loops

The present study reveals that participants’ food management habits relied on personal experience and long-standing family practices. Adjustments to portion sizes or strategies for extending product shelf life often resulted from knowledge gained through years of cooking and experimentation. This practical, experience-based approach to consumption and waste reduction aligns with Watson and Meah’s (2012) observation that household food management strategies evolve over time, guided by intuitive understandings and family traditions. However, these adaptive strategies are not without challenges, as they sometimes lead to unintentional waste despite best efforts. As participants shared,

“When you’ve been cooking for your family for a long time, you start to develop a sense of how much food you need to prepare, which helps in minimising waste.” – Household 6.

“You can’t freeze everything. Once I froze leeks and that did not go well. My husband said I should have cooked them first.” – Household 10.

While participants generally felt competent in managing household consumption needs and having minimal food waste, they also expressed

an interest in additional feedback mechanisms to further support waste monitoring and reduction—like the “Collection Insight App” proposed in the present study. While this aligns with the broader trend of using technology to promote sustainable practices and reduce food waste (e.g., Manzocco et al., 2016; Martin-Rios et al., 2020), participants’ enthusiasm for technological solutions was offset by concerns about privacy in digital waste monitoring. For instance, one participant expressed,

“I’m not sure how I would go about monitoring my waste with a digital system like you propose... I’m a bit concerned about where the data goes. On the other hand, it could help. It’s nice that you can then adjust your orders. And it says, ‘you have already bought this three times. Are you sure?’” – Household 1.

This receptiveness to feedback underscores an openness to integrating new information into daily practices, provided that privacy concerns are addressed. Meadows (2009) highlights the importance of feedback loops in fostering behavioural change through continuous reflection and adjustment, suggesting that feedback mechanisms can enhance waste awareness and encourage adaptable actions. In this context, the household waste bin plays a crucial role. As Chappells and Shove (1999) argue, bins often serve as a means to relinquish responsibility for waste, transferring the burden onto public waste management systems. Once food enters the bin, it becomes “invisible,” allowing households to avoid confronting the implications of disposal (Evans, 2012). A participant reflected,

“We have this small container wherein we put food waste. And well, it’s just nicely tucked away. So, we don’t see it. So, we’re actually not really aware of how much we throw away. Now there were three of these bags and I was like wow, three of these, how quick did this go?” – Household 3.

Interventions that make waste more visible—such as providing quantitative feedback on waste levels, as reflected in the “Food Waste Insight App” examined in this study, or incorporating reflective prompts to adjust provisioning, offer a potential solution to bring visibility to waste and encourage households to reconsider their food purchasing and disposal choices. Watson and Meah (2012) similarly argue that reflective prompts during disposal can foster mindfulness around food value, while Werkman (2024) extends this concept to the purchasing stage, showing that feedback at the point of purchase can prevent overbuying and reduce waste before food even enters the home.

The findings from this opportunity suggest that feedback loops, whether through personal experience or material interventions (e.g., apps), can play a crucial role in fostering adaptable and food waste-reducing consumption practices. These loops can enable households to adapt their practices in favour of waste reduction by adjusting purchases, portion sizes, and storage techniques, thus capturing and reinforcing household traditions that minimise waste and increase resilience over time.

4.1.5. Playing into life-changing moments

Participants indicated that significant life events often catalyse changes in household consumption practices, providing natural opportunities for reassessing and modifying food provisioning behaviours. This finding aligns with Thompson et al. (2011), who observe that life transitions frequently prompt a re-evaluation of household roles, creating space for alternative practices that can support more adaptable and waste-reducing behaviours. For example, several participants noted shifts in consumption patterns after becoming parents, transitioning from experimental to more conservative practices to meet their children’s dietary needs and preferences. Reflecting on these shifts, one participant shared,

“Before we had kids, we would take more time in cooking and we experimented a bit more... Now that the children are older, we’re starting to introduce food like curries and using chickpeas, so it gets more interesting for all of us.” – Household 1.

In this case, adaptability can allow the household to gradually incorporate diverse foods without risking excessive waste, as new ingredients are integrated thoughtfully over time.

Dietary transitions, such as adopting vegetarianism, also emerged as critical points for renewed culinary experimentation. Environmentally impactful patterns—such as reliance on animal products (Willett et al., 2019) or those that promote over-purchasing (e.g., ‘good provider’ behaviours (Visschers et al., 2016))—tend to persist, even when households express dissatisfaction (Thompson et al., 2011). However, life changes oriented toward sustainability goals can disrupt these routines and encourage waste-conscious decisions. One participant exploring vegetarianism remarks:

“We are experimenting with how we can eat vegetarian and what we like. We also just got a vegetarian cookbook. So, this study was perfect timing because we’re in an experimenting phase, otherwise we might not have dared to take on those chickpeas and bulgur [you provided us] so quickly.” – Household 11.

Although experimenting with new foods can sometimes result in initial waste if ingredients are unfamiliar or disliked, over time, households become more adept at incorporating new foods due to increased familiarity with food taste and texture. Additionally, over time, their knowledge and ability to integrate these items into meals the household enjoys increases, which can lead to reduced food waste associated with dietary transitions. This supports and extends the work of Evans (2014) and van Geffen et al. (2020) on the positive, supportive, and disruptive role that informational resources like cookbooks and food material itself, can have in facilitating transitions toward sustainable food practices.

Changes in household roles, such as assuming new responsibilities for grocery shopping, were also noted by participants in the present study as reshaping household consumption practices, with potential implications for waste reduction. Those managing food provisioning tended to exert greater influence over household consumption patterns, sometimes aligning meals more closely with their values. One participant explained,

“I eat vegetarian and I struggle to cook with animal products because of the environmental impact. But my son finds meat very tasty. Now I have a lot more influence on what is being cooked because I took over the shopping and cooking when my partner started working full time. In the beginning, the resistance to vegetarianism was fiercer. It takes a bit of getting used to and that’s okay.” – Household 10.

This finding challenges the conventional “good provider” role described in the literature, which suggests that parents often prioritise children’s preferences over their own (Aschemann-Witzel et al., 2020; Evans, 2014). In the present study, shifts in household roles enabled some parents to assert their own consumption values, even when family preferences initially resisted these changes. However, some participants also expressed adding more flexibility and effort into preparation to ensure all family members received food they enjoyed. One participant explained,

“I’m vegetarian, one of my daughters is vegetarian, and my husband is flexitarian. But what I do then, like for spaghetti, is I put two frying pans on the stove. I prepare one with the minced meat with the sauce, and the other the vegetarian sauce. Then I make it even more complicated, because I want extra vegetables, but my daughter who is also vegetarian doesn’t want that, so when the vegetarian sauce is done, I take part out for my daughter, and I throw extra cups of peas through it for myself.”—Household 2.

These findings suggest that certain lifestyle changes can open up opportunities for individuals to renegotiate household food practices in alignment with evolving personal beliefs, particularly around health and sustainability. Given the prevalence of waste as part of the ‘good provider’ identity (Aschemann-Witzel et al., 2020), challenging this

conventional role may also encourage waste-reducing practices. This reframing of household behaviour through individual norm changes aligns with broader food waste literature, suggesting that individual behaviours can reinforce household norms (Cappellini and Parsons, 2012; Evans, 2011). Additionally, it supports calls for comprehensive food waste prevention research that examines household-level dynamics alongside individual behaviours (Boulet et al., 2021b).

This opportunity suggests that significant life events provide natural opportunities to reassess and adjust food provisioning practices in ways that can support adaptable consumption. Research by Boulet et al. (2021b) and Evans (2014) underscores the potential of these moments to facilitate meaningful reductions in household food waste, especially when households are ready and willing to embrace new consumption practices. While waste-reducing intentions may sometimes be undermined by other household members’ preferences (Cappellini and Parsons, 2012), effectively leveraging life-changing events can help to establish new, waste-reducing and adaptable routines. As reflected in the findings of this theme, intervening during life-changing events requires greater attention to the underlying power dynamics within households, such as parent-child or shopper-eater relationships. Hargreaves (2011) emphasises the importance of examining these dynamics, suggesting that this remains an underexplored area in understanding how consumption practices are reconfigured during life transitions.

4.2. Limitations and future research

While the present study provides rich insights, limitations remain. The study’s sample size was limited, and the duration was relatively short. While smaller participant numbers are common in the study’s methodology, a larger sample could have provided more robust conclusions. The participants were also primarily highly educated, and although they were spread across the Netherlands to provide differing regional differences in consumption, this study does not claim to be representative of all Dutch households. Additionally, the majority of households in this study (7 out of 11) participated in Dutch, necessitating the translation of their contributions to English. Although the researcher who conducted the interviews also performed the translations to preserve the participants’ intended meanings rather than providing a verbatim translation, some nuances might have been lost in this process.

While the present study incorporates real-time reflection through the booklet to capture household behaviours and decision-making processes, it relies on self-reporting, which may be influenced by social desirability biases (van Herpen et al., 2019). To reduce socially desirable responses, the set-up ensured that the researcher collecting data and the participants did not know each other before data collection began. In addition, the researcher communicated on multiple occasions that the focus was on participants’ actual experiences and daily practices, rather than behaviours they might have assumed the researcher wanted to know. This step was intended to foster an open and honest dialogue, focusing on capturing genuine insights into adaptable consumption practices. Additionally, participants reported an important part of the data in the booklets when the researchers were not present. These booklets served as input for the discussions during the interviews. Hence, the time spent with each household was minimal, limiting the potential influence of the researcher’s presence on participants’ natural behaviours.

The absence of objective waste measurements in the present study prevents a direct assessment of waste reduction impacts through adaptable consumption practices. While measuring waste was not the intention, the study cannot confirm the impact of the areas of opportunities (themes) on actual waste reduction. Nonetheless, the identified opportunities lay a foundation for future studies, which could introduce interventions related to the opportunities and conduct weight-based waste tracking over longer periods of time and among varied

household compositions.

Despite the limitations discussed, the findings of the present study contribute valuable, rich and context-specific insights into the opportunities and challenges surrounding adaptable consumption for reducing food waste and present interesting avenues for others to build on the work, using more extensive and diverse samples to further validate and extend these findings. The study shows the potential of food-reducing behaviours by targeting adaptable and flexible behaviours, such as by explicitly recalling past experiences of effective portioning or storage when preparing food. Therefore, future research could further investigate how interventions that focus on adaptable consumption behaviours—rather than explicitly targeting food waste reduction—can contribute to food system resilience, as such behaviours may lead to food waste reduction as a beneficial secondary effect.

5. Conclusions

The present study addressed the critical issue of household food waste by advancing the concept of adaptable consumption, defined as the ability of households to adjust their food planning, preparation, and storage practices in response to both immediate disruptions and long-term changes. The findings identify five key opportunities to foster adaptable consumption: supporting flexible meal moments, reclaiming food edibility, reintegrating food into routines, integrating feedback loops, and leveraging life-changing moments. Together, these opportunities highlight the interplay between behavioural, material, and social dimensions of food consumption, demonstrating how adaptable consumption can reduce waste and enhance household resilience.

Flexible meal moments allow households to break from rigid routines, encouraging creative use of ingredients, while reclaiming food edibility through sensory cues or obtaining second opinions prevents premature food disposal. Reintegration of food into routines ensures leftovers and stored items are utilised, and feedback loops, enabled by digital tools or personal insights, encourage waste-conscious behaviours. Finally, life-changing moments, such as becoming parents or adopting new dietary habits, create natural entry points for embedding waste-reducing practices into daily life.

This work contributes to a growing understanding of how everyday practices can align with the broader goals of resilience and sustainability in food systems. By positioning households as active contributors to resilient food systems, the present study provides a pathway to reducing food waste while addressing food system goals. It offers practical insights for researchers and practitioners to design interventions that enable adaptable, resilient, and sustainable consumption practices. Future research should explore the scalability of these opportunities across diverse socio-economic and cultural contexts and examine how systemic factors, such as retail practices and policy frameworks, influence household adaptability.

CRedit authorship contribution statement

Hannah M. Goss: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Jotte I.J.C. de Koning:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization. **Nynke Tromp:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Funding acquisition, Conceptualization. **Hendrik N.J. Schifferstein:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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