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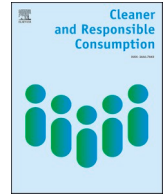
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Does household food waste prevention and reduction depend on bundled motivation and food management practices?

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ABSTRACT

The paper categorises households based on their motivations and management practices towards reducing food waste, examines the factors that differentiate households that use specific food management practices and motivation bundles, and evaluates the effect of motivations and food management practices on household food waste. Using data from households in the United Kingdom, three bundles of motivation (*saving, environmental considerations and emotions*) and management practices (*plan, inspect and proactive*) are elicited. The results show that the single predominant management practice is “inspect” while “environmental considerations” was the most common motivation. We find evidence that different motivation bundles, as well as management bundles are used in a complementary manner. The results show that of the three management bundles, being proactive is more likely to result in reducing food waste. On the other hand, considerations for the environment and negative emotion that arise after food is wasted increases the desire to reduce waste. This study highlights the interdependent nature of motivations and practices and could guide public policy and awareness campaigns for more targeted and effective waste reduction strategies. Targeted public awareness campaigns emphasising the environmental impact of food waste and educational programs integrated into existing initiatives could effectively reduce household food waste in the UK.

1. Introduction

The problem of food waste is undeniably one of the most pressing environmental and social issues we face today. Approximately 33% of food produced for human consumption, roughly 1.3 billion tonnes, is lost or wasted annually (Vilariño et al., 2017; Schanes et al., 2018). The global prevalence of food waste has wide-ranging impacts that affect various aspects of our society and the environment. This level of waste places pressures on both production resources and the environment. These include the depletion of valuable resources like water and soil, the worsening of climate change, and negative socio-economic consequences such as decreased income for farmers and heightened food insecurity (Roodhuyzen et al., 2017).

Along the various stages where food is wasted, the impact of food wasted at the household level is the most substantial, as all the energy and environmental emissions in the production and supply chain are also wasted (Schanes et al., 2018). Previous narrative suggest that this issue is particularly a concern in high-income countries where majority of food waste is generated during the household consumption phase

(Kandemir et al., 2020). The problem is not just the food that is being discarded; it is the loss of the resources—water, labour, and energy—that were invested in producing that food. This magnifies the gravity of the household food waste issue. Following this premise, this paper focuses on household food waste in a high-income country.

Researchers have approached this issue from multiple perspectives in order to gain a comprehensive understanding. Of particular interest to academics and policymakers are the motivations behind household decisions related to food waste, as well as the food management practices that households employ (Aschemann-Witzel et al., 2015; Graham-Rowe et al., 2014). However, these studies often present limitations. They mostly examine motivations and food management practices in isolation, overlooking the critical interplay and synergistic effects between these variables (Stancu et al., 2016).

More specifically, the research gaps identified centre on three main areas. First, while existing studies have delved into motivations and food management practices as crucial factors in reducing household food waste, they often consider these elements as separate or isolated variables. This leaves a gap in understanding their interrelationships and

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potential synergies. For example, the question remains: how do saving money and environmental consciousness influence meal planning? Second, the research there is much to be learnt with regards to exploring motivations across various demographics like age, gender, or socio-economic status—an area currently not well explored. Lastly, food management practices such as meal planning, the use of shopping lists, and inventory management are frequently discussed as if they operate in isolation. The literature points out that high levels of self-regulation are required for effective planning (Ananda et al., 2021), but it stops short of exploring how these practices might interact with each other and with different motivations to collectively impact food waste.

This paper aims to fill these gaps by investigating the relationship between motivations and food management practices. Specifically, this paper explores the interdependence between different food management practices and their impact on household food waste prevention and reduction. Further, it investigates the interactions between motivating factors and the effect that both motivation and management practices have on household food waste. More importantly, it examines the joint uptake and complementarity between management actions and the stimulus and complementarity between behavioural motivation. By distinguishing the nature of interrelationships among the food management practices, this paper contributes to empirical evidence on whether households put into action the practices piecemeal or as a bundle – information crucial for intervention and addressing the sustainability issue at hand.

Using survey data from a diverse sample of 402 respondents in the United Kingdom, this research study offers new insights into three primary motivations (saving resources, environmental considerations, and emotional reactions to food waste) and three key food management practices (planning, inspecting, and proactive management). We hypothesise that a household's engagement in multiple motivations and food management practices is more likely to lead to a greater reduction in food waste than focusing on a single motivational factor or management practice.

Findings in this paper indicate that while the predominant management practice is inspecting food items, the most common motivation is environmental considerations. There is a complementary relationship between different motivation bundles and management practices, suggesting that households use them in tandem rather than isolation. The study finds that proactive food management is the most effective in food waste reduction, and motivations tied to the environment and negative emotions after wasting food amplify the desire to decrease waste. This research thereby adds a new layer to our understanding of household behaviour and food waste.

This study focuses on high-income countries, particularly the UK, where most of the food waste occurs at the household consumption phase. This waste has profound environmental, economic, and social repercussions. The study highlights the importance of understanding the interaction between motivations and management practices for effective food waste reduction. It also suggests potential gaps in current awareness campaigns and recommends a more targeted approach to promoting sustainable consumption. Specifically, this study suggests that implementing targeted public awareness campaigns and integrating educational programs into existing initiatives can be effective in reducing household food waste in the UK. These findings have important theoretical implications, as they highlight the interconnected nature of motivations and practices. They also have practical implications, as they can guide the development of public policies and awareness campaigns that are more focused and effective in implementing waste reduction strategies.

The paper structure begins with previous findings on the effect of motivation and management on household food waste which are described, summarized, and critically evaluated in the section "Literature review". In "Materials and Method", the study population, sample and data sets used to achieve the paper's objectives, as well as the elicitation and data estimation methods, are presented. The "Result"

section reports the findings, while the "Discussion" section critically analyses, interprets and explains the significance of the results and highlights the implications. Finally, section "Conclusion" closes the paper with a synthesis of key points and avenues for future research.

2. A synthesis of findings on motivations and practices in household food waste reduction

Among the drivers of household food waste prevention or reduction decisions, motivation and food management practices appear to be among the factors frequently reported from studies conducted in high-income countries. Thus, the following discussion focuses on synthesising the findings of these two broadly categorised factors.

2.1. Motivations for minimising household food waste

Households are motivated by various factors in reducing food waste, many of which have been identified in the literature. The desire to save resources, mainly financial and time resources are important factors considered in the literature (van Geffen et al., 2020; Walter et al., 2023). Particularly, the desire to save money is one of the strongest motivations for preventing or reducing household food waste (Nabi et al., 2021). Some studies contend that saving money evokes a greater motivation to address household food waste than factors such as environmental and social benefits (Stancu et al., 2016; van Geffen et al., 2020). However, alternative intrinsic motivations such as time-saving i.e., the regret of time otherwise lost to planning, shopping and preparing food that is not consumed may not have the same effect on food waste as financial savings (Piras et al., 2021).

Reducing food waste offers multifaceted benefits that span financial, social, and ethical dimensions. According to Katan and Gram-Hanssen (2021), financially, it allows households to optimize their grocery spending, providing financial relief. Societally, it increases the value we place on agricultural workers and raises awareness of food scarcity issues, reducing discomfort related to food disposal. Ethically, it reinforces the importance of managing resources wisely and emphasises our collective duty to the well-being of the community and future generations. Therefore, being mindful of food waste is not only about money but also involves societal respect and ethical consciousness.

Furthermore, some findings suggest that environmental motivations reduce food waste by households (Schanes et al., 2018). However, environmental motivation is not as strong as financial motivation (Baker et al., 2009; Stancu et al., 2016; Shaw et al., 2018; van der Werf et al., 2021). This may be attributed to the benefits of cutting food waste to the environment not being tangible or immediately evident. Nevertheless, this ranking is likely to improve with more consumers paying attention to sustainability in their consumption habits. Understanding the role factors related to motivation play in reducing household food waste is widening, yet there is scope for deeper understanding across different demographics.

2.2. Household food management practices

The different phases of food waste in the household range from food purchasing, storing, preparing, and consumption. For example, a lack of planning results in consumers being unaware of their food stock and increases the likelihood of purchasing food that they have unconsumed at home (Farr-Wharton et al., 2014). With effective and efficient planning across these phases, the issue of food waste in households can be addressed (Ananda et al., 2021). Notably, the food waste management practices such as preparing meal plans, checking food levels before shopping, and having a shopping list are intertwined. Quedsted et al. (2013) report a strong positive correlation between these management practices. All the three management practices are also effective as consumers that implement them report less food waste (Janssen et al., 2017).

Shopping lists are effective in reminding consumers of food items that are needed and make shopping more efficient (Ganglbauer et al., 2013). In addition, preparing and sticking to a shopping list has been found to drive a decrease in the amount of food thrown away per capita (Stefan et al., 2013; Pearson and Perera, 2018). This reduction could either be from not buying food items by impulse or the pull of special offers on foods that are purchased but may not be consumed (Ghinea and Ghiuta, 2019). However, it is acknowledged that planning food purchases can only be effective if consumers have high self-regulation and control such that they keep to the content of the list (Ananda et al., 2021).

Adopting the practice of preparing a meal plan cuts food waste, as evidenced in an integrative review study by Geffen et al. (2020). More importantly, meal planning is pivotal as it impacts other factors related to food waste. For example, when a consumer has a meal plan, the chances are that they can organize shopping and meal preparation to reduce overstocking and leftovers and subsequently reduce food waste (Parizeau et al., 2015; Romani et al., 2018). Similarly, it has been found that household food waste tends to be lower among those that regularly check food inventory before shopping (Davenport et al., 2019). Generally, checking food inventories ensures that food waste is low.

Another practice which impacts household food waste is considering packaging for portion size when shopping, planning portion size before cooking and serving (Ghinea and Ghiuta, 2019; Brennan et al., 2021). A substantial quantity of food waste from households in the UK consists of items in their original packaging, either partly used or unopened (Quested and Murphy, 2014). However, the choice of portion sizes may be difficult for consumers, especially when larger portions are cheaper to purchase (Urrutia et al., 2019) or the portions available are in packages that are too large for household consumption patterns (Langley et al., 2021).

In recent studies, researchers have extensively examined the multifaceted issue of food waste, its implications on the environment, and potential mitigation strategies. In a study by Boulet et al. (2023) the issue of household food waste was thoroughly investigated using an Impact-Likelihood matrix approach. Through the examination of expert surveys and large-scale household data, the research pinpointed high-impact behaviours that not only help reduce household food waste but are also easy to adopt. When effectively managed, household food waste can result in significant cost savings, thus optimising the food supply chain. These behavioural adaptations are in alignment with the United Nations' Sustainable Development Goals, notably Goal 12, which emphasises sustainable consumption and production. Grounded in previous studies, Boulet et al. (2023) provide strategic insights that can assist policymakers in formulating targeted interventions. Such focused strategies have the potential to yield considerable environmental advantages, specifically addressing the myriad challenges tied to food waste.

However, there is a concurrent debate about the role of packaging materials, particularly plastics, in the narrative of food waste and environmental concerns. A study by Boone et al. (2023) undertook a comprehensive assessment of the environmental effects of different food packaging materials, employing life cycle assessment techniques. Notably, they introduced a novel metric to gauge the long-term impact on marine ecosystems. Their results revealed that traditional non-biodegradable plastics, such as polypropylene, have fewer immediate environmental repercussions during their production and disposal compared to certain biobased biodegradable alternatives. This emphasises the necessity for comprehensive life cycle assessments, especially ones that encompass concerns like food wastage and the resultant marine pollution due to poor waste management. Boone and team advocate for more refined methodologies that allow a more encompassing environmental evaluation.

Complementing these studies, research conducted by Zhang et al. (2021) explores how variations in food consumption patterns across different communities influence their carbon emissions. They suggested

that directing policy towards energy-efficient goods, primary food consumption, and reducing dining out can be effective in cutting down emissions and food waste. When looking at waste disposal, diverse communities have shown differing satisfaction levels with disposal techniques. This underscores the environmental concerns and the pressing need to enhance urban waste management strategies, with a strong emphasis on diminishing food waste and supporting recycling and composting initiatives.

3. Materials and method

3.1. Study population, sample and data collection

Households in the United Kingdom (UK) were chosen as they make a suitable example of a high-income country to investigate the association between the desire to reduce household food waste and motivation and management practice bundles. Annually, food waste in the UK amounts to 9.5 million tonnes, with households accounting for 70% of the food waste (WRAP, 2021a,b). Responses were obtained from 402 respondents between April and July 2022 through an online survey posted on Prolific to utilize their pool of respondents. These respondents passed the screen-out phase for those under 18 and those without any household food shopping or cooking responsibilities. The survey consisted of questions mostly informed from previous studies in section 2 from which self-reported responses on current and past food waste at the household level, future food waste reduction intentions, motivations and management practices were elicited.

3.2. Elicitation and estimation methods

Three main bundles of management practices, i.e., *plan*, *inspect* and *proactive*, are elicited from the survey. Specifically, the paper measures whether households *plan* (prepare a shopping list before shopping and prepare a meal plan), *inspect* (check fridge and cupboards before shopping and check household food use-by dates) and take a *proactive* role (do not buy food items by impulse, consider portion size before cooking, cook an exact quantity of food needed and use leftovers).

Similarly, three motivation bundles, *saving*, *environmental considerations*, and *emotions* obtained by asking respondents several questions on the factors that would motivate them to reduce food waste. *Savings* measured whether a reduction in both lost cost and time linked to food waste would motivate food waste reduction. On the other hand, the determination to reduce environmental impact was a proxy for *environmental considerations*, while avoiding guilt and regret from food waste constituted the components of *emotions*. We apply count data in categorising households' use of bundles. For example, a household that prepares a shopping list and a meal plan before shopping is categorised as using the 'plan' bundle, thus, is assigned 1 or otherwise 0. Lastly, respondents were asked about their perceived food waste reduction over the past two years, their weekly food waste levels (reported as percentages of how much food is thrown away in the household in a regular week) and whether they desired to reduce their household food waste in the future.

The bundles that this paper focuses on are drawn from previous studies (e.g., Roodhuyzen et al., 2017; Stangerlin and de Barcellos, 2018; Geffen et al., 2020; Boulet et al., 2021) that identify the individual components of the bundle as drivers or barriers of household food waste. In addition, readers may refer to Bravi et al. (2020) for a detailed summary of the literature from which we obtain the construct used to obtain the factors affecting household food waste.

We apply a multivariate probit (MVP) model to model the bundles of motivations and the decision to take specific management actions in the presence of interdependence. We also estimate various probit models to measure change between several predictors, the conditional use of specific bundles, and a combination of bundles (portfolio hereafter). This decision process was modelled by considering every possible

combination of the discrete management practice bundles. A similar estimation method was applied to the motivation bundles. In addition, a test of independence of the different bundles of management practices was carried out to determine if the decisions to apply these management practices were independent. Further, we estimate a binary probit regression using management action and motivation as regressors to model the dichotomous decision of the intent to reduce future food waste. We also estimate an ordinal probit regression in which weekly food waste classified into categories was the response variable and management action and motivation were the predictors.

4. Results

64% of the sample were fully responsible for food shopping, while the remainder (36%) had partial food shopping responsibility. Of the age categories of the respondent responsible for household food shopping, 34-44, 45-54, and 55-64 years constituted approximately one quarter each of the entire sample. About 79% of the household had at least two permanent residents, and over half of the respondents, 72%, had no children under the age of 16 in their household. In addition, 48.5% of respondents reside in towns, while 29.1% reside in cities. The distribution of households by their expenditure on food as a proportion of the total monthly income shows that the majority (69.15%) have a food share of less than 30%. In addition, 33.3% of households reported that the state of the food most likely to be wasted households was as leftovers that have been disposed of after being left on a plate, pan or dish, followed by food disposed of after it has been used (27.9%) and food that has been disposed of completely unused (26.2%).

The results in Table 1 show that predominant the management practice singularly employed is inspect. About a quarter (25.6%) of households inspect food as the sole management practice. A similar proportion (26.4%) did not use any management bundles. Fewer households, 15.2% combined planning with inspecting, while only 8.5% of households in the sample applied all management practices bundles. These results showing the joint use of different management bundles suggest that perhaps the decisions to apply different management practices are not independent. As such, we test the two-way independence of this postulation in Table 2. The results indicate that the decision to plan is not independent of the decision to be proactive. Similarly, we reject the hypothesis that inspect is independent of proactive. The dependence between inspect and plan is logical as the preparation of a shopping list and a meal plan would require checking the fridge and cupboards before shopping and checking household food use-by dates.

In Table 3, the result of a MVP is reported. The Wald test which evaluates the null hypothesis that $\rho = 0$, was rejected at a significance level of <0.01. Thus, according to Greene (2002), the use of the MVP model is appropriate. The Wald tests for joint significance of the coefficients suggest the rejection of the hypothesis that they are jointly equal to 0 ($p < .01$), implying that the model fitted the data reasonably well. The correlation coefficients between plan and inspect and proactive and inspect were 17.4% and 33.3%, respectively. The positive sign suggests that was a complementarity and interactive correlation

Table 1 Food management practice bundles.

Management action bundle	Sole or joint use			% using bundle
	Plan	Inspect	Proactive	
Plan	✓	-	-	12.19
Inspect	-	✓	-	25.62
Proactive	-	-	✓	3.23
Plan/inspect	✓	✓	-	15.17
Plan/proactive	✓	-	✓	1.24
Inspect/proactive	-	✓	✓	7.71
All	✓	✓	✓	8.46
None	-	-	-	26.37
Total				100

Table 2 Tests of independence of management practices.

Null	χ^2 test statistics	p-value
H ₀₁ : Plan is independent of Inspect	19.22	<0.001
H ₀₂ : Plan is independent of Proactive	1.865	0.172
H ₀₃ : Inspect is independent of Proactive	4.628	0.031

Table 3 Multivariate probit results for the unconditional use of different food management practices in households.

Variable	Unconditional use of management bundle		
	Plan	Inspect	Proactive
Level of shopping responsibility	-0.071 (0.143)	0.106 (0.141)	0.193 (0.16)
Age of food shopper	-0.055 (0.057)	0.147*** (0.056)	0.184*** (0.065)
Household size	0.012 (0.089)	-0.028 (0.086)	0.018 (0.102)
Number of young household members	0.142 (0.107)	0.068 (0.106)	-0.025 (0.123)
Household income/ consumption expenditure	0.052 (0.104)	0.106 (0.105)	0.085 (0.121)
Location	0.148 (0.093)	-0.038 (0.09)	0.095 (0.103)
Recent food waste levels	-0.341** (0.125)	-0.149 (0.104)	-0.385** (0.181)
Perceived long-term food waste reduction	-0.342** (0.124)	-0.111 (0.122)	-0.325** (0.143)
Seen a food waste campaign	-0.011 (0.141)	-0.091 (0.137)	0.063 (0.155)
Intercept	0.204 (0.427)	-0.176 (0.404)	-1.441*** (0.492)
/atrho21	0.176** (0.079)		
/atrho31	0.147 (0.09)		
/atrho32	0.346*** (0.092)		
rho21	0.174** (0.077)		
rho31	0.146 (0.088)		
rho32	0.333*** (0.082)		

rho in the output is the correlation between the error terms while atrrho is the transformed version of rho. Likelihood ratio test of rho (ρ)21 = rho31 = rho32 = 0: $\chi^2(3) = 21.64$ Prob > $\chi^2 = 0.0001$.

Figures in parenthesis are Standard errors.

*p<.1; **p<.05; ***p<.01.

between these management bundles. The results in Table 3 indicates that households with higher recent food waste levels are less likely to plan and be proactive. Similarly, those households that perceived their long-term food waste effort in the past has not resulted in lower food waste are less likely to plan and be proactive. Age (being older) exerts a positive and significant effect on the likelihood that a household will inspect food and be proactive towards reducing food waste.

As shown in Table 4, fewer variables have a statistically significant effect on the conditional use of management bundles compared to the unconditional model in Table 3. Specifically, being fully responsible for household food shopping positively impacts the complementarity between being proactive and planning. In addition, being an older food shopper positively influences the complementarity between inspect and plan and proactive and inspect. The observation that older shoppers show better planning and inspection habits, has significant implications for targeted interventions. It suggests that younger demographics may benefit from programs designed to improve planning and proactive behaviour, while older shoppers could serve as a model or mentors in community-led initiatives.

The joint food waste reduction motivations are reported in Table 5. Environmental consideration was the most common motivation in the sample households. It was reported as the sole motivation in 41.3% of

Table 4
Probit results for the conditional use of different food management practices in households.

Variables	Conditional use of management bundle		
	Inspect given plan is followed	Proactive given plan followed	Proactive given inspect followed
Level of shopping responsibility	0.084 (0.236)	0.54 ** (0.243)	0.164 (0.195)
Age of food shopper	0.288*** (0.094)	0.148 (0.095)	0.138 * (0.082)
Household size	-0.202 (0.164)	-0.094 (0.191)	0.041 (0.128)
Number of young household members	0.108 (0.176)	0.095 (0.195)	-0.044 (0.144)
Household income/ consumption expenditure	0.138 (0.184)	0.045 (0.18)	0.167 (0.151)
Location	0.034 (0.164)	0.041 (0.171)	0.023 (0.129)
Recent food waste levels	-0.106 (0.24)	-0.084 (0.294)	-0.281 (0.201)
Perceived long-term food waste reduction	0.061 (0.208)	-0.08 (0.219)	-0.209 (0.178)
Seen a food waste campaign	0.063 (0.24)	0.172 (0.247)	-0.054 (0.195)
Intercept	-0.434 (0.778)	-1.797 ** (0.84)	-1.082* (0.621)

Figures in parenthesis are Standard errors.

*p<.1; **p<.05; ***p<.01.

Table 5
Motivations to reduce food waste bundles.

Motivation bundle	Sole or joint motivator			% motivated by bundle
	Savings	Environment	Emotion	
Saving	✓	-	-	2.49
Environmental considerations	-	✓	-	41.29
Emotions	-	-	✓	7.96
Savings/Environment	✓	✓	-	2.99
Savings/Emotion	✓	-	✓	0.75
Environment/Emotion	-	✓	✓	21.89
All	✓	✓	✓	4.48
None	-	-	-	18.16
Total				100

households. Environmental considerations, in combination with emotion, were a motivation for 21.9% of households. 7.9% of the households were solely motivated by emotion, while only 2.5% were solely motivated by savings.

In Table 6, multivariate probit results for the motivation towards reducing household food waste are presented. The correlation coefficient between emotion and savings was 18.7%, with a positive sign implying complementarity between these motivation bundles. The results in Table 6 also show that households that perceived their long-term food waste effort in the past have not resulted in lower food waste are less likely to be motivated by environmental considerations. On the other hand, a household that has seen a food waste campaign recently are more likely to be motivated by environmental considerations.

The ordered probit regression presented in Table 7 shows that households that prepare shopping lists and meal plans are more likely to have lower weekly food waste. Similarly, households with higher expenditure on food as a proportion of the combined monthly income are more likely to have higher weekly food waste. In contrast, older shoppers are more likely to have less food waste. Table 7 also presents the results of a binary probit model estimating the association between motivation and management bundles and the desire to reduce food waste. Out of the three management bundles, being proactive about food waste is positively and statistically significantly related to the desire to reduce household food waste. That is households that do not buy food items by impulse, consider portion size before cooking, cook the exact

Table 6
Multivariate probit results for the motivation towards reducing household food waste.

Variables	Savings	Environment	Emotion
Level of shopping responsibility	-0.194 (0.192)	-0.145 (0.149)	0.108 (0.143)
Age of food shopper	0.009 (0.074)	-0.111 (0.059)	-0.021 (0.057)
Household size	0.008 (0.114)	0.08 (0.092)	0.015 (0.089)
Number of young household members	-0.136 (0.149)	-0.076 (0.113)	0.143 (0.106)
Household income/ consumption expenditure	0.082 (0.122)	-0.02 (0.105)	0.077 (0.104)
Location	0.046 (0.118)	0.004 (0.096)	0.09 (0.091)
Recent food waste levels	0.083 (0.132)	-0.064 (0.108)	0.032 (0.106)
Perceived long-term food waste reduction	-0.066 (0.163)	-0.298** (0.13)	-0.089 (0.123)
Seen a food waste campaign	0.007 (0.182)	0.394*** (0.15)	0.115 (0.139)
Intercept	-1.173** (0.539)	1.171*** (0.431)	-0.777* (0.418)
/atrho21	-0.07 (0.099)		
/atrho31	0.189** (0.095)		
/atrho32	0.111 (0.082)		
rho21	-0.07 (0.099)		
rho31	0.187** (0.092)		
rho32	0.11 (0.081)		

Likelihood ratio test of rho (ρ)21 = rho31 = rho32 = 0: chi2(3) = 6.79 Prob > chi2 = 0.0788.

Figures in parenthesis are Standard errors.

*p<.1; **p<.05; ***p<.01.

quantity of food needed and use leftovers are more likely to continue in the direction of reducing food waste.

On the other hand, considerations for the environment and negative emotion that arise after food is wasted is more likely to increase the desire to reduce waste. The results also show that the control variables, i. e., age, food expenditure and the adoption of a full motivation portfolio, explain the intent to reduce food waste. In other words, older food shoppers are less likely to harbour the desire to reduce waste. Households with higher expenditure on food as a proportion of the combined monthly income are more likely to harbour the desire to reduce waste, and households whose motivation portfolio includes the entire motivation bundles are less likely to desire to reduce their food waste.

In Table A1 and Table A2 in the Appendix, we provide the probit results of the factors explaining different food management practices bundles and motivation bundles aimed at reducing food waste. The main finding that arises from this analysis is that different sets of independent variables predict the outcomes in Table A1 and Table A2.

5. Discussion

The paper investigates whether different management and motivation bundles are applied jointly or independently and whether that matters for food waste reduction in households. The selection of motivations and management practices elicited are literature-driven. The findings in this paper results show that households adopted bundles of three management practices (plan, inspect and proactive) and are motivated by saving, environmental considerations and emotions, although at different rates. Since complementarities exist among motivation bundles as well as management bundles, future interventions should consider these factors when exploring drivers of food waste reduction. We revisit this point later in the discussion.

Table 7
 Probit regression estimating the association between motivation and management bundles and household food waste.

Variable	Ordered probit regression		Binary probit regression	
	Coefficient (standard Error)	Marginal effect	Coefficient (standard Error)	Marginal effect
Dependent variable	Weekly food waste		Desire to reduce food waste	
Management practice				
Prepare	-0.571*** (0.188)	0.121	0.013 (0.175)	0.003
Inspect	-0.23 (0.16)	0.054	0.124 (0.164)	0.030
Proactive	-0.491 (0.286)	0.096	0.437* (0.261)	0.092
Motivation				
Saving	0.463 (0.294)	-0.126	0.338 (0.338)	0.071
Environmental considerations	-0.047 (0.171)	0.011	0.635*** (0.165)	0.172
Emotions	0.116 (0.166)	-0.027	0.552*** (0.188)	0.122
Age of food shopper	-0.276*** (0.069)	-0.071	-0.141** (0.067)	-0.034
Household income/ consumption expenditure	0.312*** (0.105)	0.063	0.26* (0.145)	0.062
Entire management portfolio	0.689 (0.436)	-0.203	-0.219 (0.411)	-0.057
Entire motivation portfolio	-0.401 (0.483)	0.075	-1.079** (0.507)	-0.364
Intercept			0.678** (0.323)	
Log likelihood	176.72		-171.93	
LR chi2(6)	30.49		40.071	
Prob > chi2	<0.001		<0.001	
AIC	456.247		363.393	
BIC	512.197		407.354	

*p<.1; **p<.05; ***p<.01.

5.1. Determinants of past food waste

The outcome that prepare, i.e., having a shopping list and meal plan was a factor influencing household food waste aligns with previous studies (Stefan et al., 2013; Pearson and Perera, 2018; Geffen et al., 2020). Preparing ensures that food waste is prevented or managed even before the food is brought into the household. Besides, it helps to save time and money for the individual or household. However, errors in meal planning can be counterproductive as it could result in food waste. These findings support previous recommendations that it is essential to extend intervention strategies to influence consumers’ planning behaviour. For example, making available more meal plans for families with recipes and ingredients or smartphone apps that assist with meal planning.

5.2. Determinants of the intent to reduce future food waste

It is noted that among the food management practice, not buying food items by impulse, considering portion size before cooking, and cooking the exact quantity of food needed stand out in the intent to reduce food waste. Romani et al. (2018) and Bravi et al. (2020) also found that portion size and cooking more than needed have resulted in more food waste, specifically among younger consumers. Based on this finding, a reduction in food waste could be achieved by making more options in pack sizes available to consumers and ensuring that portion suggestions on food packaging provide clarity as to what a person should actually consume while ensuring that such recommendations encourage better, healthier choices. Also, developing portion calculators to guide portion sizes could be useful.

As expected, the emotions that arise from past food waste positively impact the desire to reduce household food waste. A similar result was found in Jagau and Vyrastekova (2017) and Attiq et al. (2021). This

association could be attributed to food waste having the potential to induce negative emotions ex-post and even anticipated guilt ex-ante on the one hand or the anticipation of positive emotions arising from the prevention of waste. However, the current findings are not sufficient to conclude whether or not emotion-triggering messages may be a good intervention.

The finding that consideration for the environment was the most frequently selected motivator and was associated with the desire to reduce food waste, whereas the motivation to save money was in concordance with the findings of Doron (2013). However, this finding contradicts other global studies that highlighted the salience of saving money as one of the strongest motivations for preventing or reducing household food waste compared to environmental benefits (van Geffen et al., 2020; Nabi et al., 2021). We postulate that households in the UK may be reflecting an increased public awareness of the environmental and climatic impact of food waste and an increase in pro-environmental behaviour.

We observe that households whose motivation portfolio includes the entire motivation bundle are less likely to desire to reduce their future food waste. While this may appear counterintuitive at first glance, however, this portfolio of motivations possibly has driven these households to take preventative measures towards food waste or manage their food waste to the minimum. Thus, such households perceive little or no scope to further reduce future food waste. We investigate this observation further, and we find responses that confirm this assertion, such as “our waste is absolutely minimal”, “I do not waste food”, “We have more understanding of the environmental impact of food”, “As the cost of living has risen we have become more aware of wastage and made efforts to reduce it. In addition to cost, we reduce waste to improve the environment”.

5.3. Further implications of the findings

These findings offer important evidence for intervention purposes, as it would be useful to know the food management practices and motivation for food waste decisions, which could be factored into food waste messages. Jointly modelling the observed management data is a useful first step in informing stakeholders (i.e., policy makers, the private sector, NGOs and charities, academia and research institutions, the media, and individual consumers) in the fight against food waste which practices constitute good management and can be bundled into portfolios for efficient waste prevention and management. With such information, targeted interventions could also suggest to households the portfolios which best align with their household characteristics. Specifically, policy makers can tailor public policies, campaigns, and incentives to encourage better food management in households. The private sector, including food retailers and producers, can use these insights to adapt product designs, packaging, and services to minimize waste. NGOs and charities can refine their outreach and education programs to resonate more effectively with public attitudes and behaviors. Academia and research institutions can focus on areas of consumer behavior that require further study, thereby contributing to the development of more effective waste-reduction strategies. Similarly, the media can utilize this knowledge to create impactful narratives that educate the public and encourage behavioral change, thereby amplifying the efforts of all other stakeholders.

We acknowledge that the issue of household food waste is complex and requires a wider analytical approach that takes into account several factors simultaneously. However, this paper could not consider all of these factors, for example, how food is stored or other proximal and distal factors related to food waste. Also, there is scope for future studies to widen the bundle of management practices and motivations, for example, to cover other motivations such as doing the right thing, setting a good example or consideration for others who may be hungry, and possibly employing data reduction techniques to create one or more index variables from the larger set of measured variables. Also, future

research could focus on identifying bundles of best practices by comparing motivation and management portfolios with household food waste levels. Notably, the percentage of respondents who chose the different combination of the management bundle and motivations is low so may have benefited from a different type of modelling and analysis.

The paper also has limitations in generalizing to different contexts e.g., to developing countries. The explanatory variables in this study are mostly demographics. Given that some of the demographics may be more distal factors, future studies may aim to predict the use of bundles between households from abilities (e.g., knowing how to cook creatively, knowing how to store), opportunities (e.g., having frequent unexpected changes in dinner plans), or personality (e.g., norm of being a good provider). This could allow for more useful insights in how and why different types of households may employ different bundles of practices.

6. Conclusion

Household food waste has remained a problem, especially in high-income countries. This issue has triggered cross-sector collaboration by stakeholders and facilitated the setting of food waste reduction targets. In addition, there has been numerous research with a focus on finding new ways of intervening to reduce food waste within households. However, taking the focus off reducing the current levels of food waste could hugely undermine the recent gains made. Thus, this paper enhances our understanding of good practices for reducing food in households while highlighting households' motivation to aim for such

change. The main findings are that household food waste management actions and motivations to reduce food waste are characterized by complementarities. Also, both food waste levels and the desire to reduce household food waste depend on bundles of motivation and food management practices. Studies of this nature are crucial to providing the empirical evidence needed to inform intervention that encourages the household to take preventive actions. Specifically, insights from this paper are important to policymakers and stakeholders in informing the management practices to promote or assist households in finding the motivation to reduce food waste.

Author statement

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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.

Data availability

Data will be made available on request.

Appendix

Table A1

Probit results of the factors explaining different food management practices bundles

Variables	None	Plan (only)	Inspect (only)	Proactive (only)	Plan & inspect	Plan & proactive	Inspect & proactive	All
Level of shopping responsibility	-0.066 (0.155)	-0.184 (0.184)	0.162 (0.151)	-0.013 (0.299)	-0.234 (0.175)	0.446 (0.423)	-0.047 (0.211)	0.308 (0.201)
Age of food shopper	-0.073 (0.06)	-0.23*** (0.075)	0.005 (0.06)	0.203* (0.123)	0.047 (0.068)	-0.184 (0.166)	0.157* (0.09)	0.117 (0.082)
Household size	-0.034 (0.091)	0.129 (0.112)	-0.027 (0.093)	0.023 (0.19)	-0.037 (0.105)	-0.005 (0.329)	0.133 (0.125)	-0.115 (0.142)
Number of young household members	-0.121 (0.119)	0.026 (0.13)	0.03 (0.112)	-0.072 (0.27)	0.065 (0.125)	-0.021 (0.366)	-0.255 (0.182)	0.216 (0.158)
Household income/consumption expenditure	-0.037 (0.111)	-0.048 (0.134)	-0.056 (0.114)	-0.611 (0.444)	0.05 (0.125)	-0.203 (0.42)	0.177 (0.143)	0.103 (0.143)
Location	-0.07 (0.097)	0.049 (0.12)	-0.11 (0.097)	0.27 (0.188)	0.114 (0.11)	0.204 (0.296)	-0.117 (0.138)	0.084 (0.129)
Recent food waste levels	0.291*** (0.107)	-0.149 (0.153)	0.112 (0.107)	-0.218 (0.366)	-0.27* (0.16)	0(0)	-0.313 (0.258)	-0.243 (0.22)
Perceived long-term food waste reduction	0.352*** (0.133)	-0.153 (0.156)	0.165 (0.131)	-0.285 (0.268)	-0.218 (0.152)	-0.81* (0.454)	-0.142 (0.19)	-0.198 (0.179)
Seen a food waste campaign	0.017 (0.148)	-0.035 (0.183)	-0.02 (0.147)	0.393 (0.273)	-0.034 (0.167)	0.033 (0.41)	-0.196 (0.213)	0.047 (0.196)
Intercept	-0.589 (0.432)	-0.197 (0.549)	-0.85*** (0.434)	-2.922*** (0.895)	-0.623 (0.522)	-2.172* (1.213)	-1.564** (0.664)	-1.918*** (0.627)

*p<.1; **p<.05; ***p<.01.

Table A2

Probit results of the factors explaining motivation bundles aimed at reducing food waste

Variables	None	Savings (only)	Environment (only)	Emotion (only)	Savings & Environ.	Savings & Emotion	Environ & Emotion	All
Level of shopping responsibility	-0.123 (0.171)	0.323 (0.34)	-0.143 (0.149)	0.105* (0.143)	-0.205 (0.299)	-0.079 (0.575)	0.06 (0.159)	-0.446 (0.274)
Age of food shopper	0.184*** (0.068)	-0.066 (0.123)	-0.112 (0.059)	-0.017 (0.057)	-0.077 (0.112)	0.015 (0.198)	-0.045 (0.064)	0.098 (0.104)
Household size	-0.029 (0.1)	-0.385 (0.235)	0.082 (0.092)	0.016 (0.089)	0.021 (0.169)	0.022 (0.378)	-0.038 (0.099)	0.22 (0.146)

(continued on next page)

Table A2 (continued)

Variables	None	Savings (only)	Environment (only)	Emotion (only)	Savings & Environ.	Savings & Emotion	Environ & Emotion	All
Number of young household members	0.032 (0.129)	0.254 (0.241)	-0.076 (0.113)	0.133 (0.106)	-0.087 (0.218)		0.2338** (0.114)	-0.496* (0.269)
Household income/consumption expenditure	-0.139 (0.135)	0.087 (0.211)	-0.017 (0.106)	0.079 (0.104)	0.036 (0.191)		-0.072 (0.121)	0.225 (0.157)
Location	-0.177 (0.109)	-0.171 (0.21)	0.009 (0.095)	0.084* (0.091)	-0.079 (0.181)	0.553 (0.424)	-0.095 (0.099)	0.194 (0.171)
Recent food waste levels	-0.064 (0.133)	0.183 (0.182)	-0.063 (0.108)	0.026 (0.106)	-0.032 (0.225)	0.278 (0.271)	-0.015 (0.117)	-0.095 (0.226)
Perceived long-term food waste reduction	0.349** (0.15)	-0.216 (0.28)	-0.296 (0.13)	-0.094 (0.124)	-0.306 (0.252)	-0.27 (0.517)	-0.3068** (0.136)	0.377 (0.238)
Seen a food waste campaign	-0.349** (0.17)	-0.673 (0.422)	0.399 (0.15)	0.114 (0.139)	0.154 (0.271)	0.013 (0.533)	0.138 (0.151)	0.249 (0.246)
Intercept	-1.092** (0.48)	-1.112 (0.86)	1.155 (0.431)	-0.764*** (0.417)	-1.057 (0.807)	-3.72*** (1.755)	-0.352 (0.456)	-2.603*** (0.809)

*p<.1; **p<.05; ***p<.01.

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