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Preventing Household Food Waste in Italy: A Segmentation of the Population and Suggestions for Action

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Abstract: Household food waste represents one of the main challenges threatening the sustainability of modern food systems globally. As is widely recognised, a deeper understanding of wasteful behaviour profiles is the starting point of designing intervention strategies. The overall objective of this research is to explore the role of psychological factors that influence household wasteful food behaviour in Italy and to profile consumers with heterogeneous personal attitudes towards wasting food. Starting with data collected through a web-based survey realized on a sample of 530 individuals responsible for household shopping, a principal component analysis and a two-step cluster analysis revealed three different segments of consumers with heterogeneous wasteful behaviours. The clusters differ in relation to psychological factors, such as moral attitudes and concerns about and intentions to reduce food waste. The study findings provide insights for implementing prevention, reduction, and recovery strategies tailored to these different consumer profiles.

Keywords: household food waste; psychological factors; segmentation; Italy

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1. Introduction

Food waste represents one of the main challenges threatening the sustainability of modern food systems globally, as it affects climate change, biodiversity, and pollution and exacerbates food insecurity. According to the United Nations Environment Programme Food Waste Index Report (2021) [1], 17% of the total food available to consumers in 2019 was discarded as waste. Concurrently, approximately 690 million people suffer from hunger, and three billion cannot afford a healthy diet. Further, approximately 30% of the world's agricultural land is used to produce food that is later lost or wasted, and 10% of global greenhouse gas emissions are due to food that is not consumed. This waste has a considerable detrimental impact on waste management systems and natural resource erosion.

Beginning in 2015, minimisation of food waste has been included among the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development. Target 12.3 of this agenda is to "halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains by 2030" [2].

Reducing food waste could achieve other SDG targets, and is an important way to increase the overall efficiency of the food system, improve food security and nutrition, and contribute towards environmental sustainability [2,3]. This goal was further reaffirmed at the United Nation World Food System Summit (2021) as part of the Action Tracks aimed at shifting to sustainable food consumption by developing initiatives to provide incentives to countries, businesses, and citizens to eliminate food waste. Many countries are taking action trying to reduce food waste. However, the actual implementation of the target is challenging and further efforts are necessary [3].

The daily choices of consumers are widely recognised to have a central role in preventing food waste. A deeper understanding of behavioural profiles is a starting point

to achieve this target and design public and private strategies [4,5]. Households in the European Union (EU) account for 53% of the total amount of food waste generated, an estimated 173 kg per person, which represents approximately 20% of the total food produced [6,7]. Recently, the EU Platform on Food Losses and Food Waste [8] encouraged an improved understanding of target audience segments and barriers to behavioural change to identify consumer food waste attitudes, shape more effective interventions, and facilitate their implementation at the local, national, and EU levels.

A large body of qualitative and quantitative research has been produced to explain the high share of household food waste in developed countries and suggest solutions to prevent and reduce wasteful behaviour [9–11]. However, it is difficult to intercept the numerous factors that generate wasteful behaviour, which are characterized by a strong heterogeneity in the population [12–16].

Roodhuyzen et al. [11] recently reviewed drivers of household food waste and categorised these as behavioural factors, personal skills, psychological factors, product factors, and societal factors. Concerning behavioural factors, a range of food-related routines associated with planning, purchasing, and storage practices has an important impact on food waste generation and prevention [17–22]. Various studies have highlighted how attention towards and understanding of food labelling information strongly affects wasteful behaviour [23–25].

Other studies have instead focused on how attitudinal and psychological factors may affect the adoption of these routines and wasteful behaviours. The most popular theoretical framework in explaining and predicting food waste behaviour is the theory of planned behaviour (TPB), according to which behaviour is determined by intentions and intentions in turn are driven by attitudes, subjective norms, and perceptions about behavioural control [26]. Most existing studies have explored how attitude, subjective norms, and perceived behavioural control affect intention to reduce household waste and how this intention in turn predicts household food waste behaviour [18,22,27]. The findings of several studies have revealed that moral attitudes (feelings of guilt or ethical disapproval when discarding food) predict intention to reduce food waste [22,27,28]. Other studies have pointed out that personal values and concerns directly or indirectly affect wasteful behaviours and the intention to reduce food waste [16,29,30]. At the same time, perceived behavioural control is considered a strong predictor of wasteful behaviour, as it has a large indirect relationship to food waste behaviour through the intention to reduce food waste [27,29] and through planning and shopping routines [22]. Limited knowledge or awareness about the negative consequences of food waste affects wasteful behaviour as well [5].

Although numerous studies have been performed in recent years on this topic, how psychological factors affect food waste behaviour remains unclear, especially specific features of different waster types [12,13].

The overall objectives of this research are to explore the role of psychological factors in influencing household wasteful behaviour in Italy and to profile consumers with similar personal attitudes towards waste food. The goal is to provide useful information for practitioners, and thereby to facilitate planning of public anti-waste strategies. Previous studies in Italy have revealed different segments of waster types, mainly focusing on behavioural and routine factors [13–15,31–33]. The present study was undertaken in order to enrich the existing literature by verifying the existence of different consumer profiles on the basis of psychological factors such as moral attitudes, concerns about food waste, and intention to reduce this waste. The present findings could be useful to better understand which strategies can be used to stimulate change in consumers' wasteful behaviour in order to develop policy interventions for food waste prevention tailored to the features of each segment of consumers, and more generally to engage citizens in the global challenge of reducing food waste at the consumer level by 50% by 2030.

2. Materials and Methods

2.1. Data Collection and Sample Description

A web-based survey was performed in Italy using a structured questionnaire. It was administered by a national market research company to a sample of consumers responsible for their household food shopping. Using a residence area-based quota sampling method, 530 completed interviews were obtained from north-west (26% of total), north-east (19%), central (22%), and southern (32%) Italy. The main criteria for sample inclusion were age between 18 and 75 and responsibility for household food shopping.

Participants were contacted by the national market research companies and asked to complete an online questionnaire. Before completing the survey, participants provided their informed consent to participate in the study to the data collection company. All data were collected and processed anonymously, and each participant was associated with a specific temporary identifier code. Data collection procedures were performed in accordance with the ethical standards protocol of the data collection company in full compliance with the 1964 Helsinki declaration and its later amendments.

Regarding sample description, in terms of sociodemographic profile and household composition 51% of the participants were female, 41% were 35–54 years of age, and the average family size was 2.8 children under 12 years old in 23% of cases. Nearly half (46.7%) of the participants had a family annual income between EUR 20,000 and 30,000. The majority (56%) had attained an educational diploma, and 42% were employed.

2.2. Questionnaire and Measurement

The questionnaire was structured in different sections aimed at collecting data about: (a) food related routines and personal skills, (b) food waste behavior, (c) psychological factors affecting food waste behaviour (i.e., awareness of food waste, concerns about food waste, moral attitudes towards food waste), (d) intentions to reduce food waste behaviour and perceived behavioural control, and (e) socio-demographic and household characteristics. Table 1 provides a summary of the key information collected along with the relative scale/measurements and literature references. Most of the questionnaire items were statements that required agreement or disagreement on a five-point Likert scale. The reliability of the questionnaire scales was verified using Cronbach's alpha values, taking into account only alpha values > 0.70 [34].

In reference to the first section, fifteen items associated with planning, purchasing, and management of at home practices were developed based on the prior literature [18,30,31,35], while for the leftovers management four items related to reuse and storage of leftovers were developed based on previous studies [18,28,31]. As for personal skills, in accordance with [23–25], respondents' attention towards and understanding of food labelling information were detected.

The second section included questions related to self-reported food waste behavior, measured as frequency and percentage of wasted food weekly, in line with the prior literature [14,30,31]. This section detected the drivers of food waste behavior using a set of motivations suggested from previous research [15,31,33].

The third section included questions related to food waste awareness, measured both as the self-reported degree of general awareness and as the perception of personal contributions to the phenomenon [30,36]. This section included questions related to concerns about environmental, social, and economic consequences of food waste, measured using six items [13,21,30] and moral attitudes towards food waste, measured using six items adapted from previous research [18,22,35].

In the fourth section, intention to reduce food waste was measured using four items aimed at evaluating individual purposeful behavior [18,30]; likewise, a set of six reasons were used that may, according to the literature [14,31], influence the reduction of individual wasteful behavior. Perceived behavioral control was measured by asking respondents about their perception of their personal ability to reduce individual wasteful behavior, with seven items suggested from previous research [18,27,29].

The last section included questions related to sociodemographic profiles (gender, age, and education) and household characteristics (family size, family composition, and family annual income), considering that it is suggested in the literature that food waste generation is influenced by the number of occupants in a household and the presence of children [13–15].

Pre-testing of the questionnaire's comprehensibility and length were performed with a pilot sample of twenty consumers before proceeding with the main survey.

Table 1. Questionnaire measurement/scale and references.

		Measurement /Scale	References
Food related routines	I like shopping for food	1 = totally disagree 5 = totally agree	[18,30,31,35]
	I usually plan food purchases making a shopping list		
	I usually check existing provisions before shopping		
	I usually decide what to buy only when I am at the supermarket		
	I usually purchase food that I did not include in the shopping list		
	I usually buy larger amounts of food when supermarkets offer good value for money		
	I usually buy foods products close to expiry in special offer		
	I like to try new foods that I have never tasted		
	For me the freshness of food products is very important		
	I always pay attention to the quality/price ratio		
	I always compare the appearance of the products before buying them		
	I always plan in advance what I want to cook		
	I prefer to prepare large meals rather than having to reduce portions		
	I store food appropriately in the pantry, keeping it away from heat or humidity		
	I store food properly in the refrigerator by separating it in the appropriate compartments		
Leftovers manage-ment routines	I tend to store and eat the leftovers	1 = never 5 = always	[18,28,31]
	I throw away the leftovers as they are not enough for another meal		
	I like to reuse leftovers to create new recipes		
	I take leftovers home when I go to the restaurant/pizzeria		
Personal skills	I check the expiration date on the food label	1 = never 5 = always	[23,25]
	I check the storage suggestions on the food label		
	I check the cooking suggestions on the food label		
	I check the number of portions/portion size on the label		
	Objective knowledge of "best before" on label	1 = knowledgeable 2 = not knowledgeable	
Food waste awareness	How much do you consider yourself aware about the problem of food waste?	1 = not at all 5 = very much	[30,36]
	Compared with the national population do you think to waste?	1 = less/5= more	
Self-reported food waste behaviour	How often the food is wasted in your household?	1 = never/5 = every day	[14,30,31]
	% of food wasted weekly	1 = hardly any 5 > 30%	

Table 1. *Cont.*

		Measurement /Scale	References
Drivers of food waste behaviour	Food is no longer fresh	1 = totally disagree 5 = totally agree	[15,31,33]
	Errors in shopping/cooking planning		
	I worry about any food poisoning		
	Food has expired		
	Food has not expired yet but doesn't look good		
	Wrong storage/preservation		
	The food is about to expire		
	Me/my family doesn't like the food I cooked/bought		
Moral attitudes	Wasting foods makes me feel sorry or guilty	1 = not at all 5 = very much	[18,22,35]
	I feel guilty about people who do not have enough food		
	I feel guilty for wasting environmental resources		
	I feel guilt for contributing to environmental pollution		
	I feel sorry for wasting money		
	I feel sorry for wasting time buying and preparing food		
Food waste concerns	Waste of environmental resources	1 = not at all 5 = very much	[13,21,30]
	CO_2 emissions increase due to the production and transport of food		
	Waste of economic resources for the purchase of food not consumed		
	Inequalities in food distribution among the world's population		
	Loss of biodiversity and desertification linked to intensive food production		
	Waste of economic resources linked to policies for the disposal of food surpluses		
Intention to reduce	I would like to reduce the amount of food wasted by programming my purchases better	1 = totally disagree 5 = totally agree	[18,30]
	I would like to reduce the amount of food wasted by paying more attention to the portions I prepare		
	Even if I wanted to I could not reduce the amount of food waste		
	I do not intend to change my habits		
Motivation to reduce	Think about people who don't have enough food	1 = totally disagree 5 = totally agree	[14,31]
	The chance to save money		
	The desire to efficiently manage my family spending		
	The regret of having wasted time buying and preparing uneaten food		
	The desire to be a good example for my children		
	The thought of wasted natural resources (energy, water) in the production of uneaten food		
Perceived behavioural control "I could waste less food if I had . . . "	More information about adequate storage practices	1 = totally disagree 5 = totally agree	[18,27,29]
	Availability of smaller packages in stores		
	Availability of recipes/suggestions on how to reuse leftovers		
	Availability of resealable packages		
	More information on the environmental and social impacts of food waste		
	More information on how to share or donate food		
	Information on how to correctly interpret the expiry date indicated on the label		

2.3. Data Analysis

In order to provide a synthetic description of the food routines and wasteful behaviour, descriptive analyses were performed. To explore the role of psychological factors in influencing household wasteful behaviour and profiling consumers groups with similar personal attitudes, two multivariate techniques were applied. A principal component analysis (PCA) was applied to group different variables that affect food waste behaviour into independent subsets, while a two-step cluster analysis (CA) was performed to identify differences among groups of consumers in terms of food waste behaviour. Both analyses were performed with IBM SPSS version 22 (Armonk, NY, USA: IBM Corp.).

3. Results

3.1. Food Related Routines and Personal Skills

Concerning food shopping routines, 34.5% of the surveyed consumers always make a shopping list before going to the supermarket and 39.4% always check the existing provisions before shopping. However, 36.4% often buy food that was not included in their shopping list and 16.8% decide what to buy only when they are at the supermarket. Thirty-eight percent of the respondents buy larger quantities than necessary if there are promotional offers at supermarket, and 33% usually buy new products they have never tried before while shopping. Fifty-five percent of the respondents always compare the appearance of products when shopping and 45% always pay attention to the best quality/price ratio.

Regarding food management at home, 35% of respondents often plan the preparation of meals and 26% prefer to prepare large meals rather than smaller portions. With regard to food storage practices, the interviewees always store products at home in an appropriate manner, both in the fridge (41.9%) and in the pantry (47.7%).

Relating to leftovers management routines, 46.8% of respondents never throw away leftovers that are not enough for another meal. However, a different behaviour was evident depending on whether the leftovers concerned were food from outside the home or were cooked at home. The practice of taking home leftovers from dining establishments was not widespread; only 12% of respondents did this, compared to 32% who never brought leftovers home. Storage of leftovers at home occurs more frequently (33% often and 29% always), as well as the reuse of leftovers to create new recipes (29% often and 21% always).

Concerning personal skills, respondents' attention to the information on labels was quite high. Most attention is given to the expiration date (72.5% always). Thirty-five percent always pay attention to the indication of the number of portions on the label, while 41 and 33% consider the methods of storage and preparation, respectively. Considering the ability to interpret the "best before" indication, 78% interpret it correctly, while 22% believe that beyond the date the product is no longer safe for consumption.

3.2. Wasteful Behaviour

Thirty-one percent of respondents claimed to waste food less than once a week, while 25% wasted food only on special occasions, such as during holidays. With reference to the amount of food wasted, 51.5% estimated that they wasted less than 10% of total food bought per week. On average, the respondents considered themselves to be quite aware of the food waste problem (mean $\pm$ standard deviation, 3.9 ± 0.82) and consider their own wasteful behaviour consistent with the national population (2.9 ± 1.22). The foods that are wasted most often are fruits and vegetables (2.26 ± 1.29), followed by bakery products (1.9 ± 1.17) and dairy products (1.85 ± 1.17).

The drivers of wasteful behaviour are mainly linked to concerns related to food safety and uncertainty as to proper storage practices. On average, respondents threw away food because of concerns that it was no longer safe to eat (3.6 ± 1.46), followed by concerns about potential food poisoning, even if the food had not yet expired (3.24 ± 1.42).

Respondents' intention to reduce food waste often included the desire to plan their purchases better (3.9 ± 1.17). Another relevant factor was a sense of guilt or feeling sorry about their wasteful behaviour (4.6 ± 0.75).

3.3. Multivariated Analysis

3.3.1. PCA of Psychological Variables

As recommended by the existing literature, an exploratory factor analysis with PCA was performed [13,20,21] using the score of the items related to different psychological aspects that could influence food waste behaviour. These items included moral attitudes, concerns, and intention to not waste food. The selection of the variables for factorial reduction was made on the basis of the correlations existing among the original variables, and was verified using the Bartlett's test for sphericity ($p < 0.001$).

The factors were chosen on the basis of the eigenvalue criterion, considering the cumulative variance as well as. Factors with eigenvalues over 1 were considered significant, as reported in the Scree plot (Figure 1). Factor analysis of the sixteen items revealed the existence of three factors, which together explained 67% of the original variance (Table 2). In terms of reliability, the Cronbach's alpha values were assessed to check internal consistency among the items summarised in the factor.

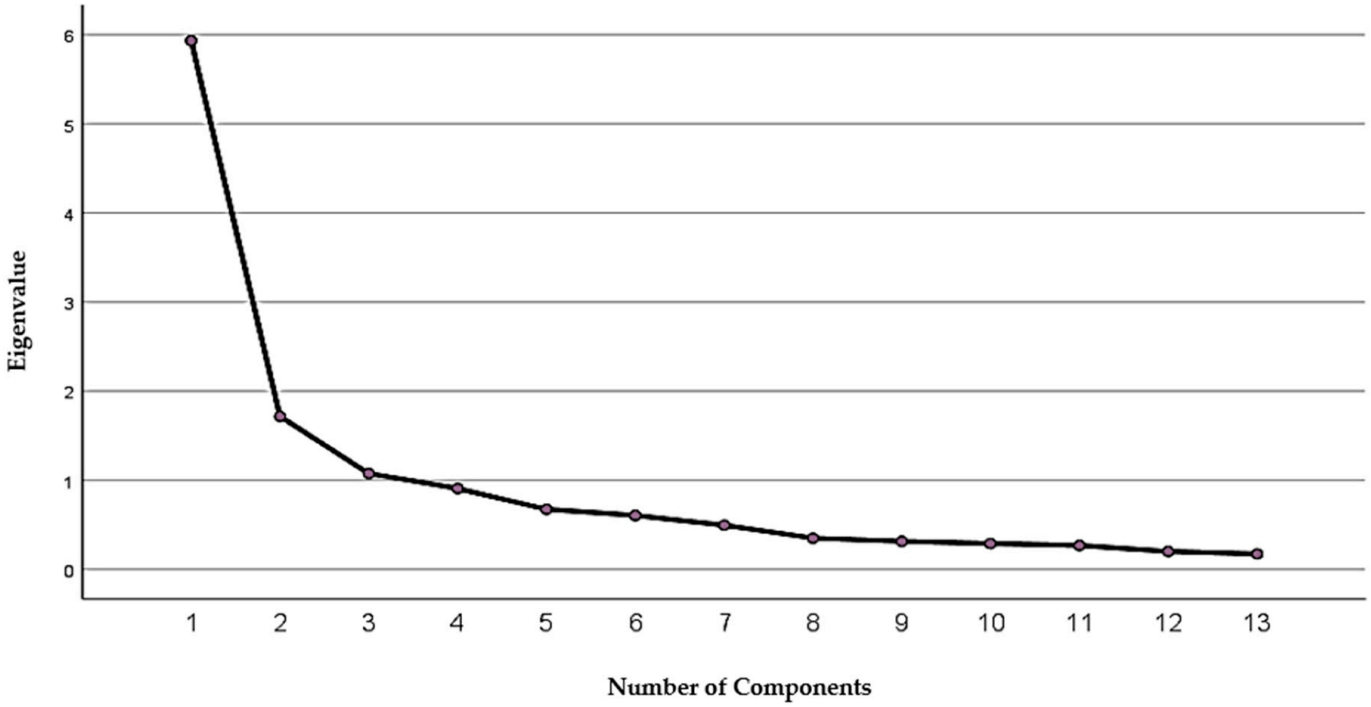

Figure 1. Scree plot of eigenvalues.

The first factor summarises a set of variables referred to as personal concerns about food waste, including social, environmental, and economics issues. This factor accounted for 32.37% of total variance. The second factor, which summarises variables related to moral attitudes that generate a sense of guilt or regret over wasted food, accounted for 20.03% of total variance. The third factor, which was the least important in terms of the total variance explained, summarises variables related to consumers' intentions to reduce food waste (14.25%).

Table 2. Matrix of rotated components.

Factor Loadings			
	Concerns α **= 0.901**	**Moral Attitudes** α **= 0.822**	**Intentions Not to Waste** α **= 0.801**
Concerns			
Waste of environmental resources	0.829	0.219	0.082
Increased CO_2 emissions due to production and transport of food	0.820	0.188	0.163
Waste of economic resources for the purchase of food not consumed	0.718	0.271	0.053
Inequalities in food distribution among world's population	0.783	0.189	0.133
Loss of biodiversity and desertification linked to intensive food production	0.838	0.144	0.140
Waste of economic resources linked to policies for the disposal of food surpluses	0.803	0.207	0.128
Moral attitudes			
Wasting foods makes me feel sorry or guilty	0.182	0.799	0.023
Guilt towards people who do not have enough food	0.412	0.811	0.216
Guilt for wasting environmental resources	0.482	0.661	0.285
Guilt for contributing to the pollution	0.427	0.601	0.421
Sorry for wasting money	0.091	0.769	0.115
Sorry for wasting time in preparing and buying food	0.183	0.673	0.223
Intentions			
I would like to reduce the amount of food wasted by programming my purchases better	0.124	0.235	0.855
I would like to reduce the amount of food wasted by paying more attention to the portions I prepare	0.150	0.145	0.898
Even if I wanted to I could not reduce the amount of food waste	0.164	0.102	−0.137
I do not intend to change my habits	−0.033	0.060	−0.081
Variance explained %	32.373	20.031	14.251
Total variance %		52.430	66.654

Extraction Method: PCA. Rotation Methods: Varimax with Kaiser normalisation.

3.3.2. Cluster Analysis

In order to identify the differences among consumers in terms of food waste behaviours and psychological variables, a two-step CA was performed. This algorithm was chosen because it is considered more efficient than k-means clustering or other hierarchical agglomerative techniques that have been reported in previous studies on the same topic [31,35]. The two-step cluster is an algorithm that is more suitable for mixed type attributes; it enables both continuous and categorical variables [37,38].

To determine the optimum number of clusters, the two-step CA provides a built-in procedure based on Akaike's Information Criterion. This provides a simple visual method to assess the results. In the present research, the three previously identified factors were used in the clustering procedure. The clustering procedure suggested the existence of three clusters. The validity of this solution was assessed using two measures. The first was cohesion, which is the proximity among members of the same cluster. The second was separation, which is the proximity among members or centroids of different clusters.

Subsequently, in order to profile each cluster, a cross-tabulation with chi-square tests was performed to compare the three clusters on the basis of demographic information, wasteful behaviour, and leftovers management (Tables 3 and 4). ANOVA analyses and Tukey pairwise comparison tests were performed to compare the three clusters and verify existing differences with respect to psychological variables, motivations that drive food waste, and actions taken to prevent it (Table 5). Additionally, the same analyses were performed to compare the level of use and understanding of food labelling information among clusters (Table 6).

Table 3. Cluster profiles based on sociodemographics.

		Cluster 1 Self-Indulgent (20%)	Cluster 2 Proactive (55%)	Cluster 3 Discouraged (25%)	Total Sample	Significance
Gender	Male	59	44	53	49.4	0.002
	Female	41	56	47	50.6	
Age	18–24	18	6	10	9.4	0.031
	25–34	17	11	21	14.7	
	35–44	19	19	17	18.6	
	45–54	20	24	18	22.1	
	55–64	15	20	21	18.8	
	>64	11	19	13	16.4	
Education level	Lower than a high school diploma	8	7	12	12.5	0.034
	High school diploma	57	52	62	57	
	Bachelor's degree	16	14	10	10	
	Master's degree	15	19	8	15	
	Post-graduate specialization/PhD	4	8	7	6	
Family income, Euro	<20.000	33	29	27	29.6	0.564
	20.000–30.000	49	45	48	46.7	
	>30.000	18	25	25	23.7	
Residence area	North-west	29	25	26	26	0.426
	North-east	18	17	25	19	
	Centre	24	22	22	23	
	South	28	36	27	32	

Table 4. Cluster characterization based on food waste behaviour and leftovers management.

		Cluster 1 Self-Indulgent (20%)	Cluster 2 Proactive (55%)	Cluster 3 Discouraged (25%)	Total Sample	Significance
Frequency of wasteful behaviour	Never	12	40	27	28	0.000
	Only on special occasion	22	25	28	25	
	Occasionally (less than a week)	44	24	32	31	
	Often (more times a week)	18	9	11	12	
	Daily	4	1	2	4	
Amount of food waste weekly produced	none	13	41	25	32	0.000
	<10%	55	48	62	51.5	
	10%–20%	27	9	12	12.5	
	20%–30%	5	2	1	2.4	
	>30%	-	-	-	1	
I keep and reuse leftovers	Never	4	2	3	3.2	0.005
	Rarely	14	9	8	9.4	
	Sometimes	40	16	31	25	
	Often	26	35	33	33	
	Always	15	38	25	29	
I use leftovers for new receipt	Never	8	5	12	8	0.000
	Rarely	21	10	18	15	
	Sometimes	35	20	34	26	
	Often	25	33	24	29	
	Always	13	28	12	21	
I take leftovers home when I go to the restaurant/pizzeria	Never	35	25	29	32	0.043
	Rarely	23	16	18	18	
	Sometimes	17	24	22	19	
	Often	16	25	20	19	
	Always	7	14	10	12	
I throw away the leftovers as they are not enough for another meal	Never	24	58	44	46.8	0.000
	Rarely	17	9	15	12.3	
	Sometimes	25	14	18	17.5	
	Often	27	10	19	16	
	Always	7	9	4	7	

Table 5. Cluster characterization based on psychological variables (mean value).

	Cluster 1 Self-Indulgent (20%)	Cluster 2 Proactive (55%)	Cluster 3 Discouraged (25%)	Total Sample	Sig.
Self-reported awareness about FW	3.6 $_a$	4.2 $_b$	3.4 $_c$	3.7	0.000
Self-evaluation of their own wasteful behaviour	2.1 $_a$	3.9 $_b$	2.8 $_c$	2.9	0.000
Concerns about FW					
Waste of environmental resources (water. energy, soil, etc.)	3.9 $_a$	4.8 $_b$	3.2 $_c$	4.2	0.000
CO_2 emissions increase due to the food production and transportation	3.6 $_a$	4.5 $_b$	2.9 $_b$	4	0.000
Waste of private economic resources for the purchase of food	3.7 $_a$	4.5 $_b$	3.3 $_b$	4.1	0.000
Inequalities in food distribution among the world's population	3.8 $_a$	4.6 $_b$	3.1 $_b$	4.1	0.000
Loss of biodiversity and desertification	3.8 $_a$	4.5 $_b$	3 $_c$	4	0.000
Waste of public economic resources linked to policies for the disposal of food surpluses	3.9 $_a$	4.6 $_b$	3 $_c$	4.1	0.000
Moral attitudes					
Wasting foods makes me feel sorry or guilty	3.7 $_a$	4.8 $_b$	4.7 $_b$	4.6	0.000
I feel guilty about people who don't have enough food	3.4 $_a$	4.8 $_b$	3.9 $_c$	4.3	0.000
I feel guilty for wasting environmental resources	3.3 $_a$	4.6 $_b$	3.5 $_c$	4	0.000
I feel guilty for contributing to pollution	3.3 $_a$	4.4 $_b$	3.4 $_a$	3.9	0.002
I am sorry for wasting money	4.4 $_a$	4 $_b$	4.4 $_a$	4.3	0.000
I am sorry for wasting time preparing and buying food	3 $_a$	4.4 $_b$	3.9 $_c$	3.9	0.000
Intentions to reduce food waste					
I would like to reduce the amount of food wasted by planning better my purchases	3.3 $_a$	4.3 $_b$	3.8 $_c$	4	0.000
I would like to reduce the amount of food wasted by paying more attention to the portions I prepare	3.4 $_a$	4.5 $_b$	3.6 $_b$	3.9	0.000
Even if I wanted to I could not reduce the amount of food waste	2.7 $_a$	2.3 $_b$	3 $_c$	2.5	0.000
I do not intend to change my habits	3.1 $_a$	2.7 $_b$	2.8 $_b$	2.9	0.031
Motivations to reduce FW					
Think about people who don't have enough food	3.6 $_a$	4.6 $_b$	3.6 $_b$	4.2	0.000
The chance to save money	4.6 $_a$	3.6 $_b$	4.2 $_c$	4	0.000
The desire to efficiently manage my family spending	3.8 $_a$	4.3 $_b$	4.2 $_b$	4.3	0.000
The regret of having wasted time buying and preparing uneaten food	4.3 $_a$	3.2 $_b$	3.8 $_c$	4.2	0.000
The desire to be a good example for my children	3.6 $_a$	4.6 $_b$	3.9 $_c$	4.2	0.000
The thought of wasted natural resources (energy, water) in the production of uneaten food	3.3 $_a$	4.2 $_b$	4.5 $_b$	4.1	0.000
Perceived behavioural control					
More information about how to store food properly	3.3 $_a$	3.5 $_b$	4 $_c$	3.7	0.000
Availability of smaller packages of food in stores	4 $_a$	3.7 $_b$	3.6 $_b$	3.8	0.000
Availability of recipes/suggestions on how to reuse leftovers	3.3 $_a$	3.8 $_b$	3.4 $_a$	3.6	0.000
Availability of resalable packages	4.3 $_a$	3.7 $_b$	3.9 $_c$	4	0.000
More information on the environmental and social impacts of food waste	3.2 $_a$	4.1 $_b$	3.4 $_c$	3.7	0.000
More information about tools to share or donate food	3.4 $_a$	4.2 $_b$	3.6 $_c$	3.9	0.000
More information on how to correctly interpret the expiry date indicated on the label	3.4 $_a$	3.3 $_a$	3.9 $_b$	3.6	0.000

p-value are related to F test in one-way ANOVA. Different subscripts indicate a significant difference at $p < 0.05$ using Tukey's HSD test.

Table 6. Cluster characterization on labelling usage (mean values).

	Cluster 1 Self-Indulgent (20%)	Cluster 2 Proactive (55%)	Cluster 3 Discouraged (25%)	Total Sample	Sig.
I check the expiration date on the food label (% always)	49	85.5	66.1	72.5	0.000
I check the storage suggestions on the food label (% always)	28.2	52.4	27	41	0.000
I check the cooking suggestions on the food label (% always)	21.4	43.1	18.3	32.6	0.000
I check the number of portions/portion size on the label (% always)	20.6	45.9	22.9	34.9	0.000
Objective knowledge of "best before" on label (% knowledgeable)	77	81	71	77.9	0.047

3.3.3. "Self-Indulgent" Cluster Profile

The first cluster includes 20% of the sample. These individuals waste the most food in terms of both frequency and quantity. Approximately 44% of individuals in this cluster reported wasting food less than or once a week. Another 18% reported wasting food more frequently. Four percent reported wasting food every day. Of the respondents in the first cluster, 55% reported wasting <10% of food weekly and 27% reported wasting 10% to 20%. The drivers of food waste in this cluster (Figure 2) included food safety concerns as well as reasons related to the taste and freshness of products.

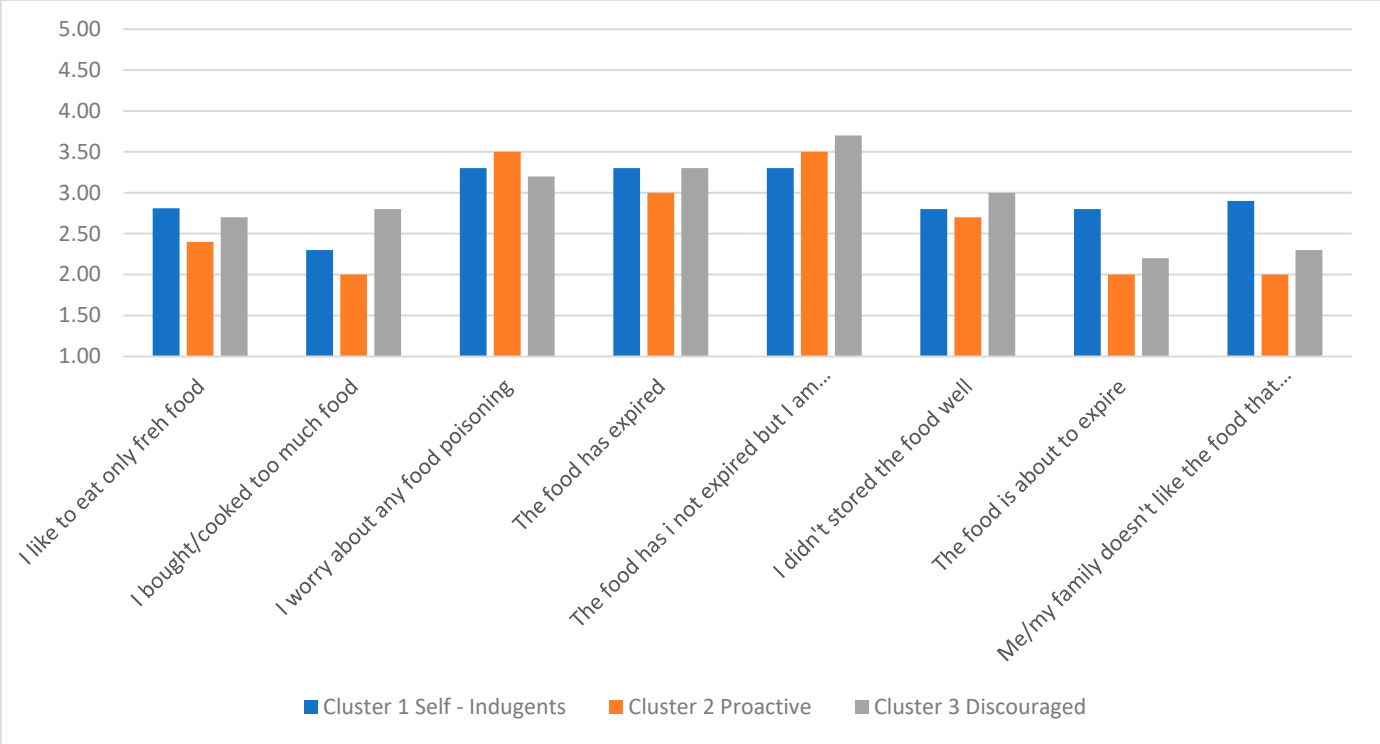

Figure 2. Cluster characterization based on drivers of food waste.

These consumers are quite aware of the problem of food waste and are concerned about the consequences, especially those related to the waste of environmental resources and public economic resources. However, their moral attitude towards the food waste issue is lesser compared with the other two clusters. The respondents consider their own wasteful behaviour less severe compared with the national population, and show the least degree of guilt with respect to their own wasteful behaviour compared with the other two clusters. Therefore, this cluster was defined as "self-indulgent". They were less inclined to change their behaviour, with less intention to reduce food waste. The possibility of saving money is the main motivation that drives this cluster to reduce their wasteful behaviour. As concerns perceived behavioural control, these individuals on average think that they might reduce their quantity of food waste if smaller and more easily resealable packs were available.

Considering the socio-demographic variables, the "self-indulgent" cluster includes mainly male respondents (59%) and individuals younger than the other two clusters (54% under 44). There is a lower incidence of individuals with a high education level, which is reflected in income as well (although this variable is not significantly different between clusters).

3.3.4. "Proactive" Cluster Profile

The second cluster is the largest (55% of respondents), and includes consumers with a lower level of food waste. As reported in Table 4, 40% of respondents claimed to never waste food, 25% only on special occasions, and 48% purported to waste <10% of food per week. These individuals are more likely to wish to change their wasteful behaviour. This cluster was defined as "Proactive". These individuals show virtuous behaviour in terms of managing leftovers, declaring that they reuse them in new recipes often (33%) or always (28%) (Table 4). Fifty-eight percent of respondents never throw away leftovers, even if they are not in a sufficient quantity to permit another meal. These individuals claim to most frequently pay attention to the different information on the labels, with greater ability to interpret the expiration date compared with other two clusters (Table 6). The main reasons that lead these individuals to waste are related to food safety concerns (Figure 2).

These individuals are particularly aware of the problem of waste and tend to be more concerned about the social and environmental impacts of waste than the other two clusters. These concerns are reflected in moral attitudes. Indeed, individuals in this cluster feel particularly guilty for their wasteful behavior, especially with reference to people who do not have enough food. Furthermore, their level of guilt for the waste of environmental resources and for having contributed to pollution is on average higher compared with the other two clusters as well.

These individuals are more inclined to change their habits in order to reduce the amount of food they waste as compared with the other two clusters, whether by better planning of their purchases or by paying more attention to the portions they prepare. Their sensitivity to the social impacts of food waste and their desire to change their own behaviour are reflected in their motivation to reduce waste, driven both by a desire to provide a good example to their children and by the thought of people who do not have enough food. Furthermore, these individuals value receiving more information on tools to share or donate excess food in order to further reduce wasteful behaviours.

This cluster includes mainly women (56%), with 63% over 45 years of age and the highest education level compared with other two clusters.

3.3.5. "Discouraged" Cluster Profile

The third cluster consists of 25% of the sample, and includes individuals who waste food mainly once a week (32%), wasting less than 10% on weekly basis (62%), although they perceive their own waste behaviour as below the national average. The reuse of leftovers is sporadic in this cluster, although there is a greater tendency to keep them compared to cluster 1. The main reasons for wasting food are linked to a greater degree to difficulties in planning food purchases and inadequate storage at home compared to the other two clusters. Their level of self-reported awareness of the issue of food waste is lower compared to the other two clusters, as are their concerns related to both social and environmental impacts. With regard to moral attitudes, the respondents in this cluster show a strong sense of guilt about their wasteful behaviour, especially as concerns those who do not have adequate food access, and they feel sorry over having wasted their money and time as well.

Considering the variables related to intentions, these individuals on average seem willing to change their behaviour, mainly motivated by the desire to efficiently manage their family spending as well as to preserve natural resources. However, they are less confident of being able to reduce the amount of waste they generate compared with the other two clusters; therefore, they can be defined as "discouraged". As for their perceived behavioural control, these individuals consider that they may reduce their level of waste by having additional information about properly storage practices, the availability of resalable packages, and information to assist in correctly interpreting food labels. With respect to the latter aspect, these consumers are those who pay less attention to the storage and preparation methods indicated on the label, and are those who have greater difficulty in correctly interpreting the expiration date (Table 6).

On average the discouraged cluster includes mainly males (53%), 38% aged between 25–44 years, and with the lowest level of education compared with clusters 1 and 2.

4. Discussion

Consistent with the previous literature [14,15,19,31,39], the present results confirm that among Italian consumers wasteful food behaviour is mainly occasional and is primarily due to concerns about product safety as well as lack of personal food management skills at home The results revealed three consumer groups with heterogeneous wasteful behaviours. The groups differed concerning psychological factors such as moral attitudes and concerns about food waste and intentions to reduce waste. "Proactive" consumers, who waste food less often, are aware of the food waste problem and are particularly concerned about its social and environmental impacts. These individuals are more inclined to change their wasteful behaviours than individuals in the other two clusters. "Self-indulgent" consumers tend to waste more while showing a lower level of guilt about their own wasteful behaviour. They generally seem to have a confused perception of the phenomenon of food waste. In line with Vittuari et al. [13], it is possible to suggest that these individuals have a warped view that food waste is a global problem, rather than an individual responsibility. The possibility of saving money is the main driver that could motivate these consumers to change wasteful behaviours. "Discouraged" consumers, by contrast, are less aware and concerned about the consequences of food waste, feel guilty for wasting food, and have little confidence in their ability to reduce the amount of waste they generate. Furthermore, they are less prone to change.

These results, when combined with the framework of a food waste hierarchy pyramid [40,41], indicate that food waste strategies concerned with prevention, reduction, reuse, and recovery should be implemented and calibrated based on the different profiles identified here, while considering the role of psychological factors as well.

Concerning prevention strategies, policymakers and practitioners should implement educational campaigns or social marketing programs that aim to raise consumers' awareness about food waste and its impacts, increase moral attitudes, and engage consumers in food waste reduction initiatives [15,42–44]. These strategies should focus primarily on the "self-indulgent" cluster, as these consumers display a limited sense of individual responsibility and need to be encouraged to adopt individual actions.

Consistent with our results, it would be useful to target these initiatives to younger individuals, considering that the "self-indulgent" cluster is mainly composed of younger people who tend to consider themselves not directly responsible for the generation of food waste. In this regard, it would be useful to involve opinion leaders that might serve as strong influencers to encourage young consumers to participate in food waste reduction, especially using social and digital media [42,45]. In addition, considering the sensitivity of this segment to the economic and financial aspects of food waste, educational campaigns should focus on the moral issues associated with food waste reduction as well as on potential economic benefits linked to savings of personal and public economic resources.

While with regard to the profile of the "discouraged" cluster, it would be more useful to promote educational interventions aimed at strengthening their perceived behavioural control, persuading them that they can modify their food waste behaviours. Empowering strategies that incorporate television, educational materials, information brochures, and labels on food packages should help to improve their food management behaviour. With reference to the latter, our results show that attention towards storage and cooking indications and the ability to interpret the date mark is lower in the "discouraged" cluster. This approach is consistent with a recent study by the European Commission that reported food waste annually generated in the EU of up to an estimated 10% linked to misinterpretation of the dates marked on labels [24]. This implies the need to revise the wording of the current EU labelling system (in line with the commitments of the EU Farm to Fork strategy) as well as to evaluate the use of alternative graphic symbols/logos or promote use of smart labels that provide visual or tactile indications about product shelf-life and food safety

risk levels [24,46]. Furthermore, development of communication and education materials that are not limited to data concerning interpretation and which refer to storage and cooking guidance as well could be valuable. These materials could focus on temperature indicators/sensors and use of temperature-sensitive inks [24].

These kinds of interventions should be implemented in combination with educational campaigns through private retailers' initiatives, such as by placing educational spaces in retail outlets or on retailers' web sites or by adding additional information to the labels of products, in order to improve consumers' shopping skills [14,20,47]. Similar initiatives have already been launched recently in Italy by retailers and by other anti-waste organisations using proposed forms of supplementary labelling that invite the consumer to verify the edibility of the food. In this regard, a concrete example in Italy is represented by the "conscious label", first introduced at end of 2021, from the Too Good To Go movement on the packaging of certain products along with the best before label. The conscious label is a pictogram that invites all consumers to verify the actual status of the product, thus avoiding discarding food that is not spoiled. However, the diffusion remains limited, and the extent of food waste prevention is underexplored.

Concerning waste reduction strategies, a further intervention target for both the "self-indulgent" and "discouraged" clusters could be the dissemination of tools or applications aimed at individual food waste calculation and monitoring. The aim would be to develop greater awareness of personal wasteful behaviours in order to track their impact and increase users' ability to control such behaviours [48].

Considering reuse strategy, our results highlight the need to implement actions to promote the use of leftovers, in particular those relating to consumption away from home. In all three clusters, the practice of taking leftovers home from eating establishments was uncommon. This result is consistent with previous evidence from studies in Italy and in other EU countries that described a sense of shame when restaurant customers to use the "doggy bag" [40,49,50]. In this regard, it would be appropriate to act on two fronts by involving restaurateurs to provide the doggy bag as a default option, regardless of the explicit request from the customer, and implementing public informational campaigns that might encourage the practice of taking leftovers home by making the use of doggy bags as a socially approved action. Furthermore, to increase the reuse of leftovers more generally at home, it would be useful to convey information via television and testimonials to provide ideas and recipes that can increase the skills of individuals to reuse leftovers.

Finally, our results suggest the need to better inform consumers about how to donate food and promote the creation of food sharing initiatives, targeted primarily to the "proactive" consumers, who are more emotionally involved in fighting waste.

In this regard, a significant number of recent initiatives have been implemented in Italy by non-profit organisations, food banks, and charity organisations to promote the recovery and redistribution of surplus food. These initiatives should be further supported, especially at the local government level, as a "win-win" solution to both lessening food poverty and reducing food waste [51]. These initiatives should seek to include consumers who are less emotionally involved, such as the "self-indulgent" [52], via a pervasive recruitment strategy that features frequent presence on popular television programmes, in newspapers, and on social media.

5. Conclusions

Reducing food waste is one of the main challenges of our times, and needs to be addressed as a priority from environmental, economic, social, and ethical perspectives.

Despite recent efforts, the target to halve per capita global food waste by 2030 remains challenging and further efforts are necessary [3,7,8]. Current research confirms that wasteful behaviour is affected by multiple drivers, including psychological factors, and shows the existence of three different waster profiles. The results provide insights for the implementation of prevention, reduction, and reuse strategies supporting the need to implement tailored interventions in the light of the heterogeneity of wasteful behaviours.

Further research aimed at the effectiveness of the specific aforementioned strategies remains necessary.

In conclusion, it is worth highlighting that the use of self-reported measurements of food waste in our research is prone to generate social desirability bias and underestimate the generation of household food waste [52–55]. In recent years, alternative methods have been developed and used to quantify food waste more accurately. These include use of diaries, photographic methods, and waste compositional analysis [55,56]; thus, future studies might apply a 'hybrid' approach.

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