

Article

# 'Not in My Bin': Consumer's Understanding and Concern of Food Waste Effects and Mitigating Factors

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Received: 28 April 2020; Accepted: 13 July 2020; Published: 15 July 2020

**Abstract:** About one third of all food produced for human consumption is wasted. Along with a lively debate on food loss and waste definition and quantification, growing attention is dedicated to the faceted dimensions of consumers' food waste. Drivers, effects, and mitigating factors have been mainly studied in isolation, with limited attention paid to their interrelationships. This study aims to contribute to a better understanding of the underlying relationship between the causes of food waste and consumers' perception of their role and of their concern on food waste effects and mitigating factors. The article draws on a survey submitted to 938 respondents while shopping at a supermarket in Italy in 2015. Data were processed by principal components to identify latent dimensions of consumer behavior, and a cluster analysis was performed to identify homogenous groups of consumers. Results emphasize the complexity of the relationship between consumers and food resources. They suggest that while consumers are aware about food waste as a global issue, they often fail to identify the individual contribution they might provide for its prevention and reduction. The article also detects three groups of consumers with different approaches to food waste management and a specific perception of the food waste phenomenon.

**Keywords:** domestic food waste drivers; domestic food waste perception; consumers' preferences; consumer behavior

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## 1. Introduction

More than one billion tons of food, corresponding to about one third of the all food produced for human consumption, is lost or wasted every year along the value chain (FAO, 2011). This situation has led to an increasing awareness on food waste among the academic world, civil society, and policy makers.

Along with a lively debate on food loss and waste definition and quantification [1–6], growing attention is dedicated to the faceted dimensions of consumers' food waste ([7,8] among others), as in industrialized countries, individuals are considered to be responsible for the larger share of the wasted food [9–11].

Household food waste was measured and analyzed, applying different methodologies including diaries [4,12–14], self-report methods such as surveys and interviews [13,15,16], and direct measurement and waste composition analysis [17–19].

All the employed methods present specific limitations that reduce their reliability and explanatory capacity, especially considering food waste quantification [20–24]. However, what is

clearly emerging is that food waste occurring in the home (consumer food waste) has multiple and interrelated drivers that influence the behavior of consumers [25,26].

This relation between consumers' behavior and food waste can be explained by applying different models such as the theory of planned behavior [27,28], that suggests that consumers' actions could be predicted building on attitude, social norms, and perceived behavioral control [16]. Moreover, to better understand the unintended character of consumer food waste, additional constructs such as knowledge [29] and routinized behaviors [4] were also introduced.

An alternative behavioral framework is built on the interaction between three constructs: Motivation, ability, and opportunity (MOA) [30–32].

In the MOA, motivation refers to the intention of an individual to perform certain actions, and is influenced by individual attitude, the awareness of individual and social consequences of actions, and by injunctive and descriptive social norms [4,33–36].

Ability refers to individual capacity to deal with a certain situation on the basis of personal knowledge and skills. In the food waste domain, ability construct is related to the proficiency with food storing and preparation skills and the ability to assess food safety (e.g., through understanding of labeling) [32,33,37,38].

Finally, opportunity is related to the access to external material and non-material resources such as time, technology, and infrastructures that allow an individual to perform the intended actions. Examples include the availability of time for grocery shopping, the access to affordable and quality food, and the possibility to buy suitable packs and portions of food [32,38–40].

Building on this framework, the work further elaborates on motivation isolating intentions related to individual goals and concerns from those related to social values.

Taking advantage on existing literature, Table 1 groups food waste drivers according to the MOA framework: Motivation, which includes individual motivations and societal values, ability, and opportunity. Moreover, it considers the role of demographic factors that are considered having an influence on food waste generation.

**Table 1.** References for factors influencing food waste.

<b>Motivation</b>	
<i>Individual motivation</i>	
Attitudes to food waste	[6,17,18,33]
Concerns for economic implications of food waste	[15–17,33,41–43]
Concerns for mitigation interventions addressing economic impacts	[26,42–44]
<i>Societal values</i>	
Concerns for environmental implications of food waste	[42,45–47]
Concerns related to food security	[16,48,49]
<b>Social norms</b>	
Concerns for mitigation interventions addressing environmental impacts (e.g., economic incentives to reduce domestic garbage)	[17,41,45,52]
Concerns for mitigation interventions addressing social impacts	[17,49,50]
<b>Ability</b>	
Knowledge (i.e., understanding of labels)	[6,13,53–59]
Skills (i.e., expertise in food preparation)	[6,13,54–59]
<b>Opportunity</b>	
Habits and frequency of shopping	[4,12,33,56]
Availability of local shopping options	[60–62]
Availability of affordable and quality food	[60–62]
<b>Demographic factors</b>	
Household size	[12,17,18]
Household composition and age structure	[12,17,18,63,64]
Employment status	[1]
Income	[19,65]
Education level	[1,61]

Societal values have been isolated from individual motivations because, despite the number of studies investigating the role of the different drivers on the generation of domestic food waste, only a small share of them suggested a potential trade-off between individual and social goals [43,66–69].

This article wants to contribute to increase the understanding of the underlying relationship between the causes of food waste and consumer's perception of their role and of their concern regarding food waste effects and mitigating factors. This study also aims to contribute to the literature on the definition of individual profiles of consumers, with a focus on the relevance of behaviors related to the reduction of domestic food waste.

For this purpose, this work investigates different aspects of consumer food waste from the perspective of the aforementioned drivers. In particular, this paper aims to investigate consumers' perception about the quantity of generated food waste (low vs. high), what implications consumers associate to its effects (environmental vs. economic costs), and their awareness about potential mitigating factors. These relations are also analyzed by identifying potential clusters defining different consumer's typologies based on their food waste perception and behavior.

## 2. Materials and Methods

### 2.1. Sampling and Questionnaire Design

This study is based on a convenience sample of 938 consumers interviewed in the city of Bologna in 2015. Interviews were organized in a supermarket to engage key individuals influencing food decisions in the household [16,69] and were performed at different times of the day (morning, lunch time, afternoon, late afternoon) to target a more heterogeneous sample. For similar reasons, the selected supermarket was a general retail store in a residential suburb of the city with an intermediate level of prices.

The questionnaire was organized in 5 sections building on the constructs of the MOA framework and aiming to investigate different aspects of consumers' purchasing behavior, attitudes, and opinions about food waste. Answers from Q3 to Q8 had to be provided on a Likert scale ranging from 0 (never) to 10 (always). This methodology allows us to avoid completely neutral answers and to collect more accurate information about respondents' preferences.

Section 1 (Q1 to Q4) refers to opportunity, and was aimed to investigate consumers' shopping habits. Section 2 (Q5) relates to ability, and was focused on routinized behaviors and on the characterization of the typologies of food (veggie/fruit, meat/fish/cold cuts, eggs/dairy products, bread, pasta, long-life products) wasted by the respondents. Section 3 (Q6 to Q8) concerns motivation (individual motivations and societal values).

Section 4 (Q9) consisted of a visual control test ('rotten apple test'), aimed to identify potential inconsistencies in consumer beliefs pairing a more abstract assessment method (Q4–Q5 statements to collect self-declared behaviors) and a more concrete one (Q9). The "rotten apple test" consisted of looking at the images of four apples in different conservation conditions (rotten, wizened, with bruises, and apple peels) and indicating what produce they would have eaten and what they would have disposed of.

Section 5 (Q10 to Q14) focused on demographics such as education level, household composition, net family income, gender, and age.

Part of the dataset has also been used in a study comparing consumers' attitude to waste food in the Italian cities of Bologna and Viterbo [15].

The design of the questionnaire, the identification of the constructs characterizing the questions (motivation, opportunity, ability, "rotten apple test," demographics), and the questions are built on literature and previous experiences [46,67,70].

A full version of the questionnaire is presented in Appendix A.

## 2.2. Data Management and Analysis

The outcome of the questionnaire consisted of a dataset with 938 single respondents and 43 variables, including five socio-demographics. To avoid losing observations, all missing answers were replaced with the median (from 0.21% to 4.96% of the total, depending on the answer), except for the variables indicating socio-demographic characteristics, which were instead left blank. The final dataset used in the analysis included all the answers on the frequency of disposing of certain products, the disposed quantity of cooked and raw products, the drivers, the effects of food waste, and the perceived mitigating factors. To estimate the consistency of the scales and battery of items (quantities, drivers, effects, and perceived mitigating factors) used in the dataset and to assess the internal coherence of consumers' answers, a Cronbach's alpha was calculated. A value of Cronbach's alpha greater than 0.7 indicates an acceptable degree of reliability. Main characteristics of the sample are presented in Table 2.

For the first step, a principal component analysis (PCA) was carried out using all the variables with the aim to investigate the presence of common factors underlying all the dimensions of the food waste phenomenon. However, no significant reduction in the complexity of the dimensions could be achieved. The Kaiser criterion (retaining only the components with an eigenvalue greater than 1) suggested that 4 components should be retained, but the loadings were considerably low, therefore the results of this first PCA were not considered.

Consequently, an additional PCA was carried out separately on several subsets of items belonging to the ability and motivation constructs. In particular, food waste drivers (subset of the ability construct), food waste effects (that includes concerns for economic implications of food waste, attitudes to food waste, concerns for environmental implications of food waste, concerns related to food security, and social norms), and perceived mitigating factors (that includes concerns for mitigation interventions addressing economic impacts, concerns for mitigation interventions addressing environmental impacts, and concerns for mitigation interventions addressing social impacts).

In this case, the Kaiser criterion suggested that 1 component should be retained for food waste drivers and effects and 2 for the perceived mitigating factors. The obtained Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, equal to 0.77, confirmed the appropriateness of running the principal component analysis. The results in terms of eigenvalues and loadings would not have changed significantly if an explanatory factor analysis was implemented instead of the PCA. Results of the principal component analysis for drivers, effects, and mitigating factors to food waste are presented in Table 3.

The second step consisted in a cluster analysis, carried out with the same sets of variables included in the PCA, to identify homogeneous clusters of consumers. This methodology has been used also by Delley and Brunner [65] to identify clusters of consumers with respect to food waste. Before implementing the cluster analysis, the variables have been standardized in order to partially overcome the problem of different levels of variability among them. The standardization process allows small deviations from the mean in case of variables with limited variance, thus avoiding the analysis being dominated by those with a higher variability. Indeed, in most cases the answers were polarized around very high or very low values, probably depending on the most socially desirable answer in each case.

After the standardization, hierarchical (single, average, complete, weighted-average, median, centroid, and Ward's linkage) and partition (k-means and k-medians) clustering strategies were implemented. Rather than selecting the final number of clusters based on researchers' convenience, the Caliński-Harabasz pseudo-F index stopping rule was employed to select the optimal number of clusters in each case. The optimal number of clusters was respectively 3, 2, 2, 3, 3, 5, and 3 for the different hierarchical clustering methods, and 2 for both partition methods. The modal number of clusters was 3 and 2. However, most strategies returned very unbalanced clusters in terms of size with the single, median, and centroid linkage strategies returning clusters of a single observation. Finally, the output of the Ward's minimum variance method (3 well-balanced clusters) was retained.

ANOVA models and Bonferroni multiple-comparison tests were used to assess whether the clusters differed significantly in terms of socio-demographic characteristics, while non-parametric Kruskal–Wallis equality of populations rank tests were employed to assess if the samples come from the same population. The same tests were used to assess whether the 3 clusters presented significant differences for the frequency of disposing certain products, the quantity thrown away, the drivers, the effects, and the perceived mitigating factors. The results of these tests are presented in Tables 4 and 5.

The final step was the analysis of the results of the ‘rotten apple’ visual test. Other studies employed similar rotten apple tests as a crucial methodological step to analyze consumers’ preferences about sub-optimal food products. Specifically, they address the relationship between visual attention and consumer purchase decisions [71] or focused on consumer decisions about products in optimal or suboptimal conditions to be taken in different settings (to be purchased in a supermarket or consumed at home) [72]. In this study, the “rotten apple test” had mainly a control function to check for discrepancies between the answers provided by respondents.

To analyze the “rotten apple test” results, the share of consumers who declared to dispose of certain typologies of apples was identified for each cluster, and the significance of the differences between the percentages was tested using ANOVA models, Bonferroni tests, as well as Kruskal–Wallis tests, in order to ensure the robustness of the results.

Then, as a further robustness check, a count variable indicating the number of apples thrown away (out of 4) was created, its distribution for each consumer cluster obtained, and the significance of the mean difference tested again by means of ANOVA models, Bonferroni tests, and Kruskal–Wallis tests.

Finally, box plots were drawn for all clusters and for all questions included in the analysis (groups of items to be assessed).

All calculations were implemented using the statistical software Stata 14.

### 3. Results

#### 3.1. Sample Description

Convenience sampling resulted in an unbalanced sample compared to the general population, though it turned out to be coherent with the shopping routines of Italian families where women are still in charge of most of the family food purchase of the households.

Respondents are relatively young (18–25-year-olds: 28.3%; 26–39-year-olds: 45.5%; 40–60-year-olds: 26.2%), or at least in their working age (18–60), and almost two thirds of them are women (63.7%). About 68% routinely shop at the supermarket where the interviews were made. The level of education is relatively high (50.0% are graduated, 44.9% have a school-leaving certificate; and 5.1% a lower secondary school certificate), and family income is aligned with a wealthy city of Northern Italy as Bologna (<1500 euro: 25.0%; 1500–3000: 47.4%; over 3000: 27.6%). In addition, 58% of the sample shops at most once a week. Furthermore, within the sample, shopping decisions are quite influenced by special offers (mean: 6.46/10).

When asked about their food waste frequency and quantity, most consumers declared rather low values (Table 2). Raw products are disposed of more often than cooked ones, while in terms of typologies ‘fruits and veggies’ are wasted in larger quantities, followed by ‘bread’, ‘eggs and dairy’, ‘meat, fish, and cold cuts’, with ‘long-lasting products’ and ‘pasta’ at the very low end, as expected. The most common cause of waste is the failure to pay attention to the expiry dates (3.7), followed by overbuying and overcooking (3.1 and 2.8), while failure to use leftovers is the least important (1.9).

**Table 2.** Distribution of the variables used in the analysis (mean and standard deviation).

Variable	Mean	St. dev.	Min.	Max.	Missing (%)
<b>Opportunity</b>					
Frequency of shopping <sup>1</sup>	2.36	0.81	1	4	0.00
Influence of special offers <sup>2</sup>	6.47	2.55	0	10	1.05
<i>Frequency of throwing away</i>					
raw products <sup>2</sup>	2.29	2.02	0	10	0.21
cooked products <sup>2</sup>	1.92	1.96	0	10	0.63
<b>Ability</b>					
<i>Frequency of throwing away</i>					
fruits and vegetables <sup>2</sup>	2.92	2.35	0	10	0.42
meat, fish, and cold cuts <sup>2</sup>	1.38	1.85	0	10	0.63
eggs and dairy <sup>2</sup>	1.80	2.05	0	10	0.42
bread <sup>2</sup>	1.82	2.28	0	10	0.53
pasta <sup>2</sup>	0.81	1.66	0	10	1.05
long-lasting products <sup>2</sup>	0.83	1.49	0	10	0.32
<i>Drivers of food waste</i>					
I purchased low-quality food <sup>2</sup>	2.03	2.88	0	10	2.11
I purchased too much food <sup>2</sup>	3.07	2.95	0	10	1.90
I cooked too much food <sup>2</sup>	2.78	2.86	0	10	1.90
I wanted to try new foods, but I didn't like them <sup>2</sup>	2.32	2.63	0	10	1.90
I purchased too big packages <sup>2</sup>	2.21	2.67	0	10	2.32
I did not pay attention to the expiry date <sup>2</sup>	3.73	3.28	0	10	1.37
I do not use leftovers <sup>2</sup>	1.86	2.79	0	10	2.11
<b>Motivation</b>					
<i>Individual motivation</i>					
<i>Attitudes to food waste</i>					
feeling uncomfortable	5.92	3.46	0	10	3.06
<i>Concerns for economic implications of food waste</i>					
loss of money <sup>2</sup>	6.84	3.00	0	10	2.74
loss of time <sup>2</sup>	3.76	3.32	0	10	3.38
<i>Concerns for mitigation interventions addressing economic impacts</i>					
more time available for shopping <sup>2</sup>	4.06	3.35	0	10	2.53
more suitable packs and portions <sup>2</sup>	5.43	3.27	0	10	2.22
more information on food products <sup>2</sup>	4.06	3.13	0	10	2.85
a better quality-to-price ratio <sup>2</sup>	5.72	3.27	0	10	2.32
better knowledge of cooking strategies <sup>2</sup>	4.30	3.39	0	10	2.53
<i>Societal values</i>					
<i>Concerns for environmental implications of food waste</i>					
causing waste management problems <sup>2</sup>	3.92	3.28	0	10	2.53
environmental damages <sup>2</sup>	4.97	3.47	0	10	2.53
<i>Concerns related to food security</i>					
throwing food that could be used by others <sup>2</sup>	7.32	3.12	0	10	2.22
<i>Social norms</i>					
causing an economic loss to the society <sup>2</sup>	4.45	3.39	0	10	2.64
<i>Concerns for mitigation interventions addressing environmental impacts</i>					
Economic incentives to reduce domestic garbage <sup>2</sup>	5.64	3.45	0	10	2.22

more sensitiveness for the environment <sup>2</sup>	6.38	3.24	0	10	2.32
<i>Concerns for mitigation interventions addressing social impacts</i>					
overcoming the economic crisis <sup>2</sup>	4.13	3.56	0	10	2.95
more care for other people <sup>2</sup>	6.42	3.23	0	10	2.22
<b>'Rotten apple' test: Respondents who would throw away</b>					
a rotten apple <sup>3</sup>	0.97	0.17	0	1	2.00
the apple peel <sup>3</sup>	0.66	0.47	0	1	4.01
a withered apple <sup>3</sup>	0.21	0.40	0	1	4.96
a beaten-up apple <sup>3</sup>	0.08	0.27	0	1	4.85

Notes: The indicators were calculated after replacing the missing values with the median. n = 948. <sup>1</sup> From 1 = 'less than once a week', to 4 = 'more than three times a week'. <sup>2</sup> From 0 = 'never/nothing/not at all/irrelevant', to 10 = 'very often/a lot/absolutely/very relevant'. <sup>3</sup> 1 = 'yes'; 0 = 'no'.

As for the effects, most people seem concerned primarily with the social impact of food waste: "Throwing away food that could be used by others" (7.3). This is followed by the concern about "loss of money" (6.8) and by "feeling uncomfortable" (5.9), which suggest the existence of social norms against the actions that generate domestic food waste. In contrast to these self-centered effects, perceived mitigating factors indicated as most effective are those that involve social values instead of pure economic factors, like "more care for other people" (6.4) and "care for the environment" (6.4). These results suggest that individuals consider mitigating factors ideally important, but prioritize their personal wellbeing when making their decisions.

### 3.2. Principal Component Analysis

As reported in Table 3, only one principal component was retained for the drivers and the effects, while two principal components were retained for perceived mitigating factors.

Concerning the principal component of the 'drivers', the loadings associated with overcooking and overbuying are the highest, followed by those associated with trying new products which are sometimes not liked, and to the presence of oversized packages (too big packs). The key to describe this particular component seems to be the search for 'overabundance' by a relevant part of the sample. Factors related to the low quality of food and to lack of attention to the expiry date have a lower role in explaining the variety of answers related to food waste, while still being relevant.

**Table 3.** Results of the principal component analysis for drivers, effects, and mitigating factors to food waste.

Drivers	PC1 <sup>1</sup>	Effects	PC1 <sup>1</sup>	Mitigating Factors	PC1 <sup>1</sup>	PC2 <sup>1</sup>
low-quality food	0.312	loss of money	0.305	more time for shopping	0.263	0.287
too much food purchased	0.415	loss of time	0.311	more suitable portions	0.298	0.386
too much food cooked	0.433	feeling uncomfortable	0.371	more info on products	0.373	0.283
new products not liked	0.420	waste management issues	0.415	better quality for price	0.366	0.290
too big packs purchased	0.406	economic loss to society	0.431	economic incentives to waste less	0.361	-0.209
no care to expiry date	0.300	loss of redistributable food	0.371	better cooking strategies	0.305	0.012
not using leftovers	0.335	environmental damages	0.421	ending economic crisis	0.323	0.105
				more care for others	0.339	-0.526
				more sensitiveness for the environment	0.356	-0.523
Eigenvalue	3.005	Eigenvalue	3.499	Eigenvalue	3.915	1.337

Variance explained (%)	0.429	Variance explained (%)	0.410	Variance explained (%)	0.435	0.149
KMO	0.774	KMO	0.816	KMO		0.830

Notes: Only the components with an eigenvalue above 1.0 are retained. <sup>1</sup> Loadings associated to that component. KMO: Kaiser-Meyer-Olkin.

While food waste drivers are related to individual actions, like overbuying, the principal component of the ‘effects’ has more to do with impacts on the society as a whole, such as economic losses for the society, environmental problems, and waste management issues. On the other side, personal consequences, such as the loss of money and time, seem less relevant.

Finally, the principal components of the ‘mitigating factors’ are two. The first one identifies strategies leveraging individual wellbeing (e.g., better quality-to-price ratio, economic incentives to reduce domestic garbage), but also improving the information available on food products. The second one is (negatively) associated to value-related mitigating factors, such as increasing one’s care for others, and sensitiveness for environmental problems, which leverage on community.

### 3.3. Clusters of Consumer Typologies

The cluster analysis allows the identification of three groups of consumers characterized by different degrees of concern towards food waste, whose names are chosen based on their most salient features: ‘Pragmatic consumers’ (22.3% of the sample), ‘thrifty altruists’ (44.8%), and ‘aware wasters’ (32.9%).

The ‘Pragmatic consumers’ group is the most balanced in terms of sex, with males accounting for 47.4% of its members. However, very young people (18–25 years old) are overrepresented, their family size is the largest of all clusters (3.1), and the household income (2728 Euros a month) is the highest of all groups.

The ‘Thrifty altruists’ group is composed by two-thirds of females; consumers in this group represent the oldest cluster, with members aged 18–25 accounting for 19.1%, and those over 40 for 36.5%; they have the smallest families (2.8 members) and the lowest household income (2534 Euros a month).

Finally, the ‘aware wasters’ group is mostly represented by women (70.3%), very young (18–25), and young adults (26–39), both of which are overrepresented (31.8% and 48.2%, respectively). The family size in this group is slightly above the average (3.0), while the income is the closest to the average (2629 Euros a month).

Table 4 presents the average answer of the members of every group to each battery of items. Table 5 summarizes their socio-demographic characteristics. Table 6 details, for each cluster, the average answer of its members to the single items, including the results of tests of significance for the difference, and an assessment of the deviation from the overall sample mean. Finally, considering consumers’ answers to the ‘rotten apple’ test, Table 6 suggests whether food waste behaviors diverge significantly across clusters.

**Table 4.** Mean score for each group of items of the questionnaire, by cluster.

	<b>Pragmatic Consumers</b> 22.3% n = 211	<b>Thrifty Altruists</b> 44.8% n = 425	<b>Aware Wasters</b> 32.9% n = 312	<b>One-Way ANOVA</b>	<b>Kruskal-Wallis</b>
Frequency of waste (average)	1.91 <sup>D</sup>	1.26 <sup>D</sup>	3.39 <sup>D</sup>	0.0000	0.0001
Quantity wasted (average)	0.54 <sup>D</sup>	0.39 <sup>D</sup>	1.00 <sup>D</sup>	0.0000	0.0001
Drivers of food waste (average)	0.40	0.35	0.94 <sup>D</sup>	0.0000	0.0001
Effects of food waste (average)	1.00 <sup>D</sup>	1.91	1.85	0.0000	0.0001
Perceived mitigating factors to food waste (average)	0.67 <sup>D</sup>	1.47	1.50	0.0000	0.0001
Frequency of shopping (average)	2.43	2.32	2.37	0.2927	0.3424



Influence of special offers (average)	5.88	6.57	<b>6.74</b>	0.0004	0.0002
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Notes: <sup>D</sup> Significantly different from other clusters (Bonferroni-adjusted significance). **Bold** = highest value among clusters; *Italics* = lowest value among clusters.

**Table 5.** Socio-demographic characteristics, by cluster.

	Pragmatic Consumers	Thrifty Altruists	Aware Wasters	Overall Sample	One-way ANOVA	Kruskal- Wallis
Gender of the respondent						
Male (%)	47.4	32.6	29.7	34.9	0.0001	0.0015
Female (%)	52.6	67.5	70.3	65.1		
Age of the respondent (years)						
18–25 (%)	33.2	19.1	31.8	26.4	0.0000	0.0001
26–39 (%)	38.9	44.5	48.2	44.5		
40 or more (%)	28.0	36.5	19.9	29.1		
Family size (average)	3.08	2.79	3.04	2.94		
1 member (%)	7.6	13.2	13.5	12.0		
2 members (%)	24.2	31.8	19.6	26.1	0.0024	0.0031
3 members (%)	30.3	23.8	28.0	26.6		
4 members (%)	28.9	25.2	27.0	26.6		
5 or more members (%)	9.0	6.1	11.9	8.7		
Household income (average, Euros)	2728.37	2533.74	2629.48	2608.87		
less than 1000 (%)	4.3	8.7	5.9	6.8		
1000–1500 (%)	12.0	19.0	22.5	18.6		
1500–2000 (%)	20.7	19.0	18.9	19.4	0.0780	0.0421
2000–3000 (%)	32.7	26.0	26.7	27.7		
3000–4500 (%)	19.2	18.3	15.0	17.4		
4500–6500 (%)	8.7	4.3	3.6	5.1		
more than 6500 (%)	2.4	4.6	7.5	5.1		
Education						
lower middle school (%)	7.1	6.1	5.1	6.0	0.1446	0.1976
high school (%)	49.3	42.1	43.7	44.2		
university or higher (%)	43.6	51.8	51.1	49.7		

**Table 6.** Answers to the single items of the questionnaire for all clusters.

	Pragmatic Consumers	Thrifty Altruists	Aware Wasters	One-way ANOVA	Kruskal- Wallis
Frequency of throwing away different categories of food (Cronbach's $\alpha = 0.65$ ).					
raw products	<u>2.02</u> <sup>D,e</sup>	<u>1.48</u> <sup>D,f</sup>	<b>3.58</b> <sup>D,c</sup>	0.0000	0.0001
cooked products	1.79 <sup>D, e</sup>	1.04 <sup>D, f</sup>	<b>3.20</b> <sup>D,c</sup>	0.0000	0.0001
Quantity thrown away for different categories of products (Cronbach's $\alpha = 0.82$ ).					
fruits and vegetables	<u>2.49</u> <sup>D,e</sup>	<u>1.98</u> <sup>D,f</sup>	<b>4.49</b> <sup>D,c</sup>	0.0000	0.0001
meat, fish, and cold cuts	1.35 <sup>D,e</sup>	0.58 <sup>D,f</sup>	<b>2.49</b> <sup>D,c</sup>	0.0000	0.0001
eggs and dairy	1.48 <sup>D,e</sup>	0.93 <sup>D,f</sup>	<b>3.19</b> <sup>D,c</sup>	0.0000	0.0001

bread	2.00 <sup>D,a</sup>	0.88 <sup>D,f</sup>	<b>2.99</b> <sup>D,c</sup>	0.0000	0.0001
pasta	0.90 <sup>D,a</sup>	0.22 <sup>D,f</sup>	<b>1.56</b> <sup>D,b</sup>	0.0000	0.0001
long-lasting products	0.74 <sup>D,e</sup>	0.37 <sup>D,f</sup>	<b>1.50</b> <sup>D,b</sup>	0.0000	0.0001
Importance of reasons for throwing away food (Cronbach's $\alpha = 0.77$ ).					
I purchased low-quality food	1.14 <sup>f</sup>	1.54 <sup>e</sup>	<b>3.31</b> <sup>D,b</sup>	0.0000	0.0001
I purchased too much food	2.21 <sup>f</sup>	1.85 <sup>f</sup>	<b>5.32</b> <sup>D,d</sup>	0.0000	0.0001
I cooked too much food	1.99 <sup>D,f</sup>	1.47 <sup>D,f</sup>	<b>5.11</b> <sup>D,d</sup>	0.0000	0.0001
I tried new foods, but didn't like	1.50 <sup>f</sup>	1.55 <sup>g</sup>	<b>3.92</b> <sup>D,c</sup>	0.0000	0.0001
I purchased too big packages	1.84 <sup>D,e</sup>	1.11 <sup>D,f</sup>	<b>3.95</b> <sup>D,c</sup>	0.0000	0.0001
I did not look at the expiry date	<u>2.84</u>	<u>3.08</u> <sup>e</sup>	<b>5.23</b> <sup>D,b</sup>	0.0000	0.0001
I do not use leftovers	1.65 <sup>D,e</sup>	0.92 <sup>D,e</sup>	<b>3.30</b> <sup>D,c</sup>	0.0000	0.0001
Relevance of different effects of food waste (Cronbach's $\alpha = 0.83$ ).					
loss of money	<u>4.99</u> <sup>D,g</sup>	<b>7.43</b> <sup>a</sup>	7.30 <sup>a</sup>	0.0000	0.0001
loss of time	2.07 <sup>D,g</sup>	4.09 <sup>a</sup>	<b>4.46</b> <sup>a</sup>	0.0000	0.0001
feeling uncomfortable	2.56 <sup>D,h</sup>	<b>7.14</b> <sup>b D</sup>	6.51 <sup>D,a</sup>	0.0000	0.0001
waste management problems	1.62 <sup>D,g</sup>	<b>4.67</b> <sup>a</sup>	4.46 <sup>a</sup>	0.0000	0.0001
economic loss to the society	1.76 <sup>D,h</sup>	<b>5.51</b> <sup>D,b</sup>	4.85 <sup>D,a</sup>	0.0000	0.0001
loss of redistributable food	3.76 <sup>D,i</sup>	<b>8.60</b> <sup>D,b</sup>	<u>7.98</u> <sup>D,a</sup>	0.0000	0.0001
environmental damages	2.04 <sup>D,h</sup>	<b>5.93</b> <sup>b</sup>	5.64 <sup>a</sup>	0.0000	0.0001
Usefulness of different strategies to reduce food waste (Cronbach's $\alpha = 0.83$ ).					
more time for shopping	2.31 <sup>D,g</sup>	4.27 <sup>D</sup>	<b>4.95</b> <sup>D,b</sup>	0.0000	0.0001
more suitable portions	3.66 <sup>D,g</sup>	5.62 <sup>D</sup>	<b>6.37</b> <sup>D,b</sup>	0.0000	0.0001
more info on products	2.08 <sup>D,g</sup>	4.43	<b>4.88</b> <sup>b</sup>	0.0000	0.0001
better quality for price	<u>3.84</u> <sup>D,g</sup>	5.99 <sup>D</sup>	<b>6.62</b> <sup>D,b</sup>	0.0000	0.0001
economic incentives to waste less	2.79 <sup>D,h</sup>	<b>6.57</b>	6.29 <sup>a</sup>	0.0000	0.0001
better cooking strategies	2.43 <sup>D,g</sup>	4.65	<b>5.08</b> <sup>a</sup>	0.0000	0.0001
ending economic crisis	2.67 <sup>D,f</sup>	4.24 <sup>D</sup>	<b>4.98</b> <sup>D,a</sup>	0.0000	0.0001
more care for other people	3.05 <sup>D,i</sup>	<b>7.66</b> <sup>D</sup>	7.01 <sup>D,a</sup>	0.0000	0.0001
more environmental care	3.07 <sup>D,i</sup>	<b>7.52</b> <sup>D</sup>	<u>7.05</u> <sup>D,a</sup>	0.0000	0.0001

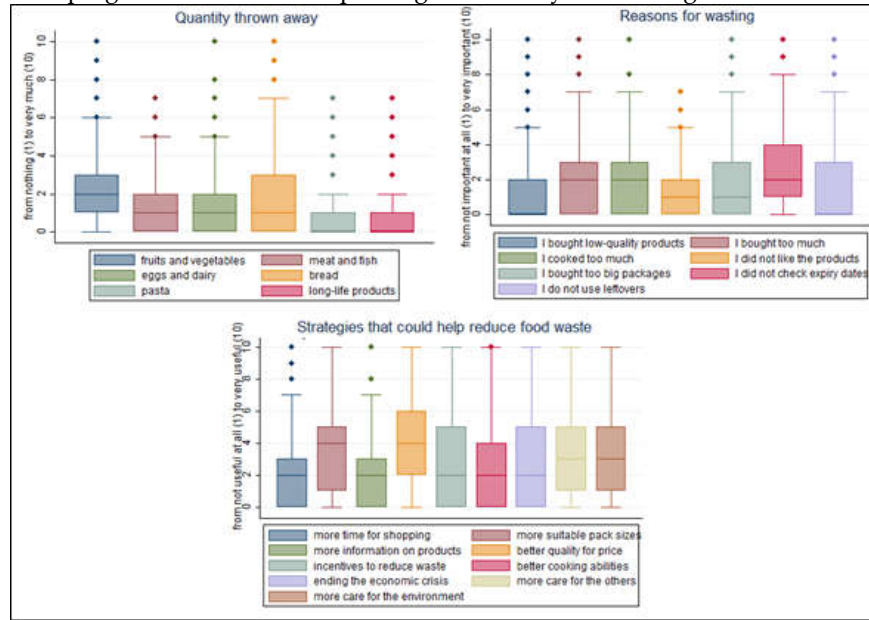
Notes: <sup>D</sup> Significantly different from the other clusters (Bonferroni-adjusted significance). 'a' = cluster mean 0.00–0.25 standard deviations above the mean for the entire sample ('b' = 0.25–0.50; 'c' = 0.50–0.75; 'd' = 0.75–1.00); 'e' = cluster mean 0.00–0.25 standard deviations below the mean for the entire sample ('f' = 0.25–0.50; 'g' = 0.50–0.75; 'h' = 0.75–1.00; 'i' = 1.00–1.25). Underlined = highest average answer within the category for that cluster. **Bold** = highest value among clusters for that item; *Italics* = lowest value among clusters for that item.

The average answers by battery of items and by cluster, reported in Table 4, provide a synthetic overview of the characteristics of each single cluster. First, when asked how often they dispose of raw or cooked products, and how much they waste of different typologies of food, 'aware wasters' selected by far the highest values, 'thrifty altruists' the lowest. 'Aware wasters' rated highest the drivers of food waste, 'thrifty altruists' the effects, although in the latter case only the average score of 'pragmatic consumers'—the lowest—is significantly different from the other clusters. 'Aware wasters' also rated the mitigating factors highest but, again, only the average score of 'pragmatic consumers'—the lowest—differs significantly. Finally, the frequency of shopping does not present statistically significant differences among clusters, according to ANOVA and Kruskal–Wallis tests, and the influence of special offers differ significantly across groups: The former is higher for 'pragmatic consumers', the latter for 'aware wasters'.

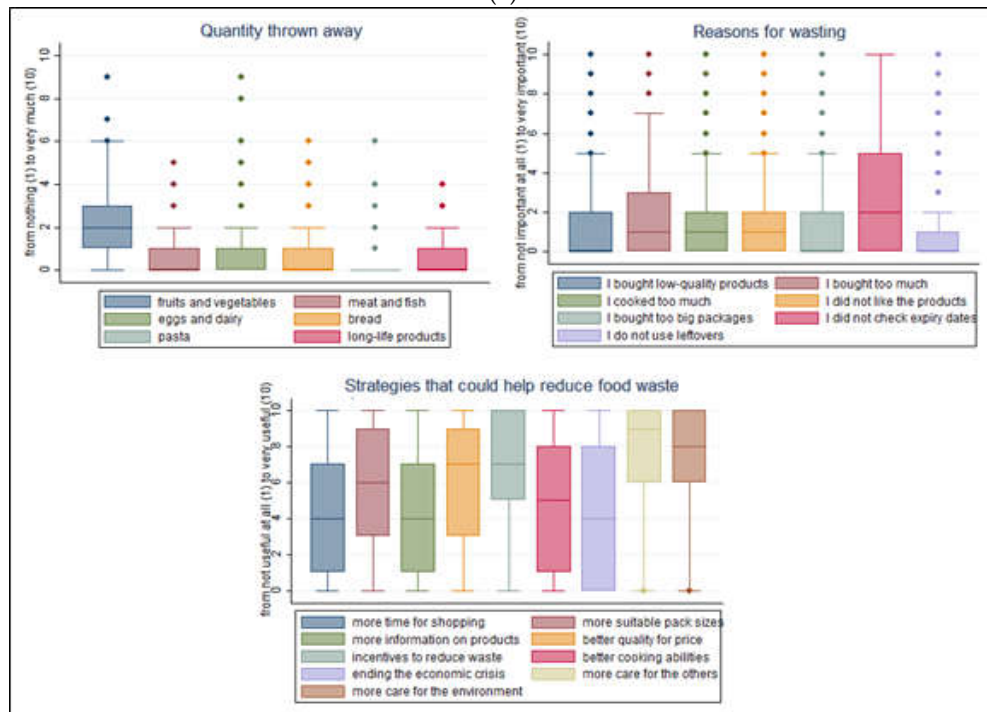
Below, the three clusters are described more in details based on the content of Figure 1 and Tables 5 and 6.

'Pragmatic consumers' are probably represented by young families with children earning more than one salary, and with both spouses equally likely to shop for food. They are named 'pragmatic' because, when asked about the effects of food waste, they highlight the loss of money above all and, when asked about mitigating factors, they indicated a better quality-to-price ratio as the top one. They tend to waste food rarely, but not too rarely. They identify no specific reason for wasting, no

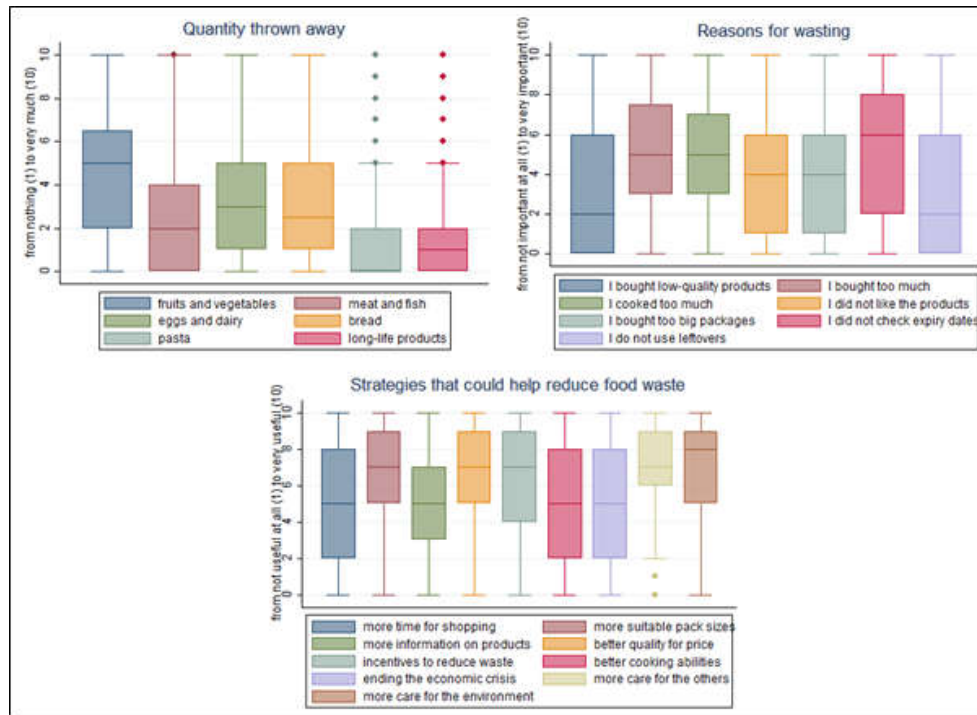
specific effect, and no specific remedy; they score lowest among all clusters for all items of the latter two groups of questions. They probably tend to avoid wasting not because they are value-oriented, but due to their pragmatism aimed at improving their family’s wellbeing.



(a)



(b)



(c)

**Figure 1.** (a): Quantity thrown away, reason for wasting, and strategies to reduce food waste—answers from ‘Pragmatic consumers’ cluster. (b): Quantity thrown away, reason for wasting, and strategies to reduce food waste—answers from ‘Thrifty altruists’ cluster. (c): Quantity thrown away, reason for wasting, and strategies to reduce food waste—answers from ‘Aware wasters’ cluster.

Besides declaring to waste the least regardless of the product, ‘Thrifty altruists’ parsimony derives from being the least likely to over-purchase, overcook, buy too big packages, and throw away their leftovers (although they may fail to pay attention to the expiry dates). Meanwhile, they are the most sensitive to the effects of food waste, being particularly concerned about the loss of redistributable food and the economic loss for the society, and feeling uncomfortable when throwing away food. Their altruism is proved by their concerns, as well as by their favored mitigating factors: Caring more about others and the environment, and introducing incentives to reduce domestic garbage. They are probably people in their late adulthood and pensioners, who have internalized anti-waste norms and care for the public good.

Finally, ‘aware wasters’ can be described as ‘waster’ since they are those who throw away by far the most, with raw products and fruits and vegetables dominating. Meanwhile, their awareness derives from their tendency to declare several drivers: Among others, they tend primarily to over-purchase and overcook, but also to pay little attention to expiry dates. As for the effects, compared to the other clusters, they assign the highest average score to the loss of redistributable food, but they are the most concerned about the loss of time, meaning that the respondents are probably those responsible for shopping and cooking in their family. They are also eager to show that they are willing to experiment several mitigating factors, prioritizing those linked to shopping, such as having more time, more suitable portions, better quality, and ending the economic crisis. In addition, they are the most influenced by special offers. These characteristics suggest that ‘aware wasters’ are women who spend much time shopping and cooking, thus knowing their actual waste levels and its drivers. Despite wanting to show concern for the food waste problem, they seem not to translate it into more virtuous behavior.

### 3.4. Self-declared Waste Behavior across Clusters

The impact of injunctive social norms related to the undesirability of food waste becomes clear when comparing the results from the ‘rotten apple’ test with answers regarding the quantity of wasted food: Results presented in Table 7 highlight that 379 respondents (48%) are not clearly coherent with the declared food waste behavior.

**Table 7.** Self-declared waste behavior (visual question).

Share of Respondents Who Usually Throw Away...	Pragmatic Consumers	Thrifty Altruists	Aware Wasters	Overall Sample	One-Way ANOVA	Kruskal–Wallis
rotten apples	0.930 <sup>D</sup> --	<b>0.988</b> +	0.977 +	0.971	0.0000	0.4944
the apple peel	0.609 -	<b>0.677</b> +	0.664 +	0.654	0.2450	0.3865
withered apples	<b>0.292</b> +	0.116 <sup>D</sup> -	0.270 +	0.205	0.0000	0.0001
beaten-up apples	0.072 -	0.052 -	<b>0.126</b> <sup>D</sup> +	0.078	0.0010	0.2338
Average	0.476	0.458	0.509	0.477		
Percent of respondents who would throw away...						
0/4 of the apples shown	6.19	0.74	1.00	2.01		
1/4 of the apples shown	23.20	27.54	24.08	25.45		
2/4 of the apples shown	49.48	61.79	52.17	55.92		
3/4 of the apples shown	17.53	7.94	16.72	12.95		
4/4 of the apples shown	3.61	1.99	6.02	3.68		
Average	1.89	1.83	2.03	1.91	0.0035	0.0240

Notes: <sup>D</sup> Significantly different from other clusters (Bonferroni-adjusted significance). **Bold:** Highest value among clusters for that item; *Italics:* Lowest value among clusters for that item.

The level of coherence is quite different among the clusters. The behaviors suggested by the answers to the previous questions are partially confirmed, with ‘thrifty altruists’ wasting the least, and ‘aware wasters’ the most. ‘Pragmatic consumers’ show a more polarized behavior, with more consumers than in the overall sample wasting either none of the apples depicted, or 3–4 of them; ‘Thrifty altruists’ are more homogeneous, with 89.3% of them wasting 1–2 apples. However, within-group variability is much larger than between-group one; therefore, few variables are significantly different across groups. The only significant differences are ‘pragmatic consumers’ throwing away the rotten apple less often (93.0% of them), ‘thrifty altruists’ throwing away the withered apple less often (11.6%), and of ‘aware wasters’ wasting the beaten-up apple more often (12.6%).

## 4. Discussion

Insights from answers on the perceived mitigating factors of food waste suggest a higher declared concern for the social and environmental consequences of food waste. As for the incentives aimed at reducing household waste, the set of solutions perceived as more effective appears to be very generic, with a limited linkage with the main drivers, and with no reference to individual commitment. Moreover, improving the information on foodstuffs, extending the time available for purchasing, and ensuring an in-depth knowledge of food preparation are effective, while less explicative mitigating factors.

Instead, the PCA applied to the entire dataset did not identify any latent sub-determinant of food waste. This means that consumers’ food-related choices (purchase, storage, preparation, consumption) as a whole could be unrelated to food waste generation and its effects, basically decoupling food behavior and food waste behavior. The average ratings of the effects and the perceived mitigating factors, on the other side, are higher compared to those related to the determinants: This shows how the phenomenon is not ignored by consumers.

However, the awareness about the existence of potential food waste mitigating factors does not necessarily lead to their adoption by all the consumers, as emerged by the results of the cluster analysis presented in Section 3.3.

Moreover, the results of cluster analysis highlight several commonalities with other studies aiming at describe the profile of consumers facing the food waste issue. The number of clusters identified in this work are consistent with findings from Di Talia et al., Richter, and Romani et al. [42,68,73], while they are lower than Delley and Brunner, and Gaiani et al. [65,66], that detect respectively 5 and 7 groups.

Other commonalities are also present among the characteristics of the clusters. For example, the “guilty food wasters” cluster described by Richter et al. [74], shares some attributes with the “aware wasters” group, where the components of the groups know that they are wasting and are aware of the negative consequences of this behavior. An additional example is represented by the “conscious consumers” cluster, identified by Di Talia et al. [68], and the “pragmatic consumers” cluster, where the members of these clusters are aware of the economic relevance of food waste, since they perceive it as a monetary loss, while aspects related to the environmental impact of food waste are considered less important. In addition, the “self-indulgent” cluster identified by Delley and Brunner [65] and the “conscious-forgetful” cluster described by Gaiani et al. [66] share some characteristics with the “aware-wasters” cluster, in particular concerning the awareness about the negative effects of wasting food.

However, if compared to other studies employing clustering techniques, the findings of this paper present some differences in terms of considered drivers of food waste and on the role of different aspects, such as cooking skills, food management skills, and comprehension of labels, in the definition of respondents’ behavior.

Differences emerge especially with the “conservatives” cluster described by Delley and Brunner [65], where the role of values, both personal and religious, is considered as a driver of food waste. Conservative consumers try to avoid food waste, since they show a great concern for the monetary loss caused by spoiling food. Moreover, the authors suggest the role of commitment to domestic duties as a predictor of virtuous behavior, where a greater commitment indicates a higher concern for food stock management and a lower propensity to waste.

Concerning the role of elements as cooking skills, food management skills, and comprehension of food labels, authors such as Gaiani et al. and Romani et al. [66,73] consider them as drivers of food waste, while in this study they are considered as potentially mitigating factors.

## 5. Conclusions

The results shed light on the complexity of the consumers’ food waste behaviors. Insights from the survey suggest different levels of interpretation. The first level is consistent with a number of studies and can be ascribed to product typologies: While fruit and vegetables are the more frequently declared to be wasted, followed by bread and dairy products, long-lasting products show lower frequencies. The second level is related to consumer behavior and consumer typologies: Three groups of consumers are identified, each with different approaches to food waste management and perception of the food waste phenomenon.

Regarding consumers’ concern for food waste, the PCA highlighted a rather clear dichotomy between the private and the public sphere. This emerges when considering individual and social motivations of individual food waste. Proposed motivations of food waste, which are based on respondents’ food behavior, are assigned low absolute and relative values (frequencies) compared to individual and social drivers. Instead, the only cause of food waste partially independent from personal behavior, represented by the expiry date, is assigned the highest average relevance among food waste drivers. This might be related to a cognitive bias, which leads consumers to underestimate their personal ‘responsibility’ in wasting food, while giving more importance to factors which are not directly linked to their own actions.

Concerning food waste effects, stronger importance is assigned to their impact on private (monetary losses, difficulties in managing waste) rather than on societal wellbeing (waste management, socio-economic impacts, environmental implications). This suggests a warped knowledge of the phenomenon (‘it exists, but it’s not my fault’, ‘Not In My Bin’) and a limited sense of individual responsibility toward the food waste problem, highlighting a potential paradox

between the high perception of food waste as a global issue (public level understanding and concern) and the limited perception of individual responsibilities (private level understanding and concern).

This is coherent with the familiarity hypothesis often used in social sciences to explain the 'Nimby effect' and the related social acceptance, as in the case of new technologies in the renewable energy domain. According to Wolsink [75], social acceptance can be represented by a "U-shaped curve". This curve, ideally having the level of acceptance of policies and/or measures (high vs. low) on the ordinate and time on the abscissa, is showing that the level of acceptance is high/positive when individuals have to express their support "in general" (the environmental impact of food waste is high and food waste implies economic losses for the society as a whole), but low/negative when they have to get engaged directly, since declared frequencies of individual drivers of food waste register low values compared to those related to public drivers.

In the familiarity hypothesis the 'U-shaped curve' is completed because once the new technology is adopted, the level of acceptance grows again (right side of the U curve). This might also happen for food waste concern, if the understanding of the individual responsibility in the generation of food waste, and therefore the importance of taking individual actions, increase when education and awareness interventions are implemented.

Insights from the cluster analysis highlight the presence of three clusters of consumers: Thrifty altruists, pragmatic consumers, and aware wasters, with specific food waste patterns.

The 'thrifty altruists' cluster is the most representative in terms of share of responders (44.8%), followed by the 'aware wasters' (32.9%) and the 'pragmatic consumers' (22.3%) groups.

In terms of self-declared food waste levels, the 'thrifty altruist cluster' shows the lower declared wastage values, while the 'aware wasters' group registers the highest values of food waste, especially related to raw products and fruit and vegetables. This emerges from the answers given to the questionnaire, where average values of frequency and quantity of self-declared food waste by 'aware wasters' are the highest of the sample. Answers provided to the 'rotten apple' test also confirm this characteristic, since the 'aware wasters' cluster presents the highest share of respondents who declare to discard options three and four of the four typologies of apples presented.

Moreover, potential inconsistencies could be identified in the answers of the consumers belonging to the 'aware wasters' cluster: They are aware, since they identify several causes of food waste (e.g., overcooking and over-purchasing) and declare a willingness to change their behavior, but their high levels of wastage do not match with this self-declared consciousness.

Concerning the potential implications of this study, observed results can provide valuable insights for the elaboration of interventions and policies aimed to the reduction of the food waste generated by the households, which are tailored on the effective behaviors and perceptions of different typologies of consumers. In particular, inputs for tailored and effective policies and interventions can derive from the analysis of the relationship between concerns and behaviors and the different degrees of compliance between the two aspects, which is one of the most influencing aspects characterizing the generation of domestic food waste.

Finally, concerning limitations, this study relies on the employment of a household survey based on the awareness of respondents, therefore, as in similar surveys, it might be affected by a social desirability bias. Being self-declared behaviors and concerns present a low variance and a significant asymmetry for low values in case of negative behaviors and high values in case of positive opinions. In this study, this limitation was addressed by standardizing values while future research might consider to adopt and analyze alternative methods to measure such variables.

**Author Contributions** “Conceptualization L.F., M.S., M.V.; methodology L.F., M.M., S.P., M.S., M.V.; validation, M.S., L.F. and A.S.; formal analysis, S.P. and M.M.; investigation, L.F., M.S., M.V.; data curation, M.M.; writing—original draft preparation, S.P., M.S., M.V.; writing—review and editing, L.F., M.M. and A.S.; visualization, M.M.; supervision, A.S., M.S., M.V.; All authors have read and agreed to the published version of the manuscript.”

**Funding:** This research received no external funding

**Conflicts of Interest:** The authors declare no conflict of interest.

Appendix A

## Questionnaire

### Q1. Where do you usually buy food?

- This Leclerc-Conad Hypermarket
- Other hypermarkets/supermarkets
- Discounts
- Neighborhood shops/farmers’ markets
- Directly from producers/form purchasing groups
- Depends on situation

### Q2. How often do you buy food?

- Less than once a week
- Once a week
- 2–3 times a week
- More than 3 times a week

### Q3. From 0 to 10, please indicate how your food purchasing is influenced by special offers (buy 3 pay 2, discounted products...)—0 = not at all/never; 10 = very influenced/always

1	2	3	4	5	6	7	8	9	10
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### Q4. How often do you discard food? (0 = never; 10 = very often)

Non cooked food (eggs, canned food...)	1	2	3	4	5	6	7	8	9	10
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Cooked food (pasta, ...)	1	2	3	4	5	6	7	8	9	10
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### Q5. From 0 to 10, please indicate the quantity of food products you discard among following categories (0 = never; 10 = very often)

Fruit and vegetables	1	2	3	4	5	6	7	8	9	10
Meat/fish/processed meat	1	2	3	4	5	6	7	8	9	10
Eggs/dairy	1	2	3	4	5	6	7	8	9	10
bread	1	2	3	4	5	6	7	8	9	10
pasta	1	2	3	4	5	6	7	8	9	10
Long-lasting products (canned food, frozen food, dried food, beverages, sweets)	1	2	3	4	5	6	7	8	9	10

### Q6. How important for you are the following motivations when you discard food products? (0 = not at all; 10 = very important)

Low quality of food	1	2	3	4	5	6	7	8	9	10
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I bought too much food	1	2	3	4	5	6	7	8	9	10
I cooked too much food	1	2	3	4	5	6	7	8	9	10
I tried new products that I did not like	1	2	3	4	5	6	7	8	9	10
I bought large packs of food to save money	1	2	3	4	5	6	7	8	9	10
I did not pay attention to expiry dates	1	2	3	4	5	6	7	8	9	10
I do not reuse leftovers	1	2	3	4	5	6	7	8	9	10





**Q7. How important are the following consequences of discarding food products? (0= not at all; 10 = very important)**

Loss of money	1	2	3	4	5	6	7	8	9	10
Waste of time	1	2	3	4	5	6	7	8	9	10
I feel uncomfortable	1	2	3	4	5	6	7	8	9	10
It causes problems with waste management	1	2	3	4	5	6	7	8	9	10
It causes economic losses for society	1	2	3	4	5	6	7	8	9	10
Food that could have been useful for other people is discarded	1	2	3	4	5	6	7	8	9	10
It causes environmental damage	1	2	3	4	5	6	7	8	9	10

**Q8. Please indicate how the following mitigating factors could reduce the quantity of discarded food (0= not at all; 10 = very important)**

To have more time to purchase food	1	2	3	4	5	6	7	8	9	10
To have packs and portions that better fit with my needs	1	2	3	4	5	6	7	8	9	10
To have more information on food products	1	2	3	4	5	6	7	8	9	10
To have a better value for money	1	2	3	4	5	6	7	8	9	10
Incentives to reduce in-house waste reduction	1	2	3	4	5	6	7	8	9	10
To have a better knowledge of cooking techniques	1	2	3	4	5	6	7	8	9	10
The end of the economic crisis	1	2	3	4	5	6	7	8	9	10
To have more attention to the others	1	2	3	4	5	6	7	8	9	10
To have more concern to environmental issues	1	2	3	4	5	6	7	8	9	10

**Q9. Which of the following apples will you discard?**

			
<p>a) rotten</p>	<p>b) peel</p>	<p>c) wizened</p>	<p>d) bruised</p>
<p><input type="checkbox"/> 1) yes <input type="checkbox"/> 2) no</p>	<p><input type="checkbox"/> 1) yes <input type="checkbox"/> 2) no</p>	<p><input type="checkbox"/> 1) yes <input type="checkbox"/> 2) no</p>	<p><input type="checkbox"/> 1) yes <input type="checkbox"/> 2) no</p>

**Q10. What is your education level?**

- Elementary school/no title
- Middle school
- High school
- University or higher

**Q11. How many people are in your family, including you?**

- 1
- 2
- 3
- 4
- More than 4

**Q12. What is the total net monthly income of you family?**

- Less than 1.000€
- 1.000–1.500€
- 1.500–2.000€
- 2.000–3.000€
- 3.000–4.500€
- 4.500–6.500€
- Over 6.500€

**Q13. You are**

- Male
- Female

**Q14. Please indicate your age**

- 18–25 years old
- 26–39 years old
- 40–60 years old

**Appendix B: Food waste habits for each cluster****Table A1.** Food waste for each typology of food: ‘Pragmatic consumers’.

	0 (Never)	1	2	3	4	5	6	7	8	9	10 (very often)
Frequency of throwing away different categories of food (%)											
raw products	30.12	24.94	24.71	13.41	3.53	2.35	0.47	0.24	0.24	0.00	0.00
cooked products	23.70	24.17	22.75	15.64	8.53	3.32	1.90	0.00	0.00	0.00	0.00
Quantity thrown away for different categories of products (%)											
fruits and vegetables	15.17	19.91	19.43	21.33	10.9	5.21	3.79	1.90	0.95	0.95	0.47
meat, fish, and cold cuts	36.49	25.12	19.91	10.43	3.79	2.84	0.95	0.47	0.00	0.00	0.00
eggs and dairy	36.49	24.64	18.01	9.00	5.69	2.37	2.37	0.47	0.47	0.00	0.47
bread	34.12	20.85	12.80	9.48	6.64	8.06	3.32	2.37	0.47	0.95	0.95
pasta	62.09	17.54	7.58	3.79	3.32	2.37	2.37	0.95	0.00	0.00	0.00
long-lasting products	62.09	18.96	10.43	4.74	1.42	0.47	0.95	0.95	0.00	0.00	0.00

**Table A2.** Food waste for each typology of food: ‘Thrifty altruists’ cluster.

	0 (Never)	1	2	3	4	5	6	7	8	9	10 (very often)
Frequency of throwing away different categories of food (%)											
raw products	30.12	24.94	24.71	13.41	3.53	2.35	0.47	0.00	0.00	0.24	0.24
cooked products	41.41	32.24	13.41	7.76	3.76	1.41	0.00	0.00	0.00	0.00	0.00
Quantity thrown away for different categories of products (%)											
fruits and vegetables	19.06	27.06	21.18	16.00	7.53	6.35	1.88	0.71	0.24	19.06	27.06
meat, fish, and cold cuts	62.35	24.71	8.24	3.06	0.94	0.71	0.00	0.00	0.00	0.00	0.00
eggs and dairy	46.35	31.76	11.76	6.35	2.35	0.47	0.47	0.00	0.24	0.24	0.00
bread	56.00	22.82	9.18	5.88	2.82	2.12	1.18	0.00	0.00	0.00	0.00
pasta	62.09	17.54	7.58	3.79	3.32	2.37	2.37	0.95	0.00	0.00	0.00
long-lasting products	73.65	19.06	4.71	1.65	0.94	0.00	0.00	0.00	0.00	0.00	0.00

**Table A3.** Food waste for each typology of food: ‘Aware wasters’ cluster.

	0 (Never)	1	2	3	4	5	6	7	8	9	10 (very often)
Frequency of throwing away different categories of food (%)											
raw products	7.69	14.1	14.74	16.03	14.42	12.18	6.73	7.37	5.45	0.96	0.32
cooked products	12.82	12.18	20.83	15.71	9.94	12.18	4.81	6.09	3.21	1.28	0.96

Quantity thrown away for different categories of products (%)											
fruits and vegetables	7.69	7.37	10.9	12.5	9.29	14.10	13.14	10.58	8.97	4.17	1.28
meat, fish, and cold cuts	25.64	16.99	17.95	9.29	9.62	8.97	4.17	2.56	2.24	1.92	0.64
eggs and dairy	14.10	14.42	16.35	13.14	13.78	10.9	6.73	4.81	3.85	1.28	0.64
bread	24.68	13.46	11.86	12.18	9.62	8.33	7.05	4.17	4.81	2.88	0.96
pasta	84.00	12.47	2.35	0.71	0.24	0.00	0.24	0.00	0.00	0.00	0.00
long-lasting products	42.63	22.44	16.03	5.77	3.21	3.85	1.92	0.64	1.92	1.28	0.32

## References

1. Wasserman, G.; Schneider, F. Edibles in household waste. In Proceedings of the Tenth International Waste Management and Landfill Symposium, S. Margherita di Pula, Cagliari, Italy, 3–7 October 2005.
2. FAO. *Global Food Losses and Food Waste—Extent, Causes and Prevention*; FAO: Rome, Italy, 2011.
3. Katajajuuri, J.-M.; Silvennoinen, K.; Hartikainen, H.; Jalkanen, L.; Koivupuro, H.-K.; Reinikainen, A. Food waste in the food chain and related climate impacts. In Proceedings of the 8th International Conference on Life Cycle Analysis, Saint-Malo, France, 1–4 October 2012.
4. Stefan, V.; van Herpen, E.; Tudoran, A.A.; Lähteenmäki, L. Avoiding food waste by Romanian consumers: The importance of planning and shopping routines. *Food Qual. Prefer.* **2013**, *28*, 375–381, doi:10.1016/j.foodqual.2012.11.001.
5. Östergren, K.; Gustavsson, J.; Bos-Brouwers, H.; Timmermans, T.; Hansen, O.-J.; Møller, H.; Anderson, G.; O'Connor, C.; Soethoudt, H.; Quested, T.; et al. *Definitional Framework for Food Waste*; SIK—The Swedish Institute for Food and Biotechnology: Göteborg, Sweden, 2014; ISBN 9789172903319.
6. Quested, T.; Parry, A.; Eastal, S.; Swannell, R. Household Food Waste in the UK, 2015. *Nutr. Bull.* **2017**, doi:10.1111/j.1467-3010.2011.01924.x.
7. Canali, M.; Amani, P.; Aramyan, L.; Gheoldus, M.; Moates, G.; Östergren, K.; Silvennoinen, K.; Waldron, K.; Vittuari, M. Food Waste Drivers in Europe, from Identification to Possible Interventions. *Sustainability* **2016**, *9*, 37, doi:10.3390/su9010037.
8. Porpino, G. Household Food Waste Behavior: Avenues for Future Research. *J. Assoc. Consum. Res.* **2016**, *1*, 41–51, doi:10.1086/684528.
9. Gunders, D. *Wasted: How America is Losing up to 40 Percent of Its Food from Farm to Fork to Landfill*; NRDC Issue Paper; <https://www.nrdc.org/sites/default/files/wasted-food-IP.pdf> (accessed date: 24 April 2020)
10. Monier, V.; Mudgal, S.; Escalon, V.; O'Connor, C.; Gibon, T.; Anderson, G.; Montoux, H.; Reisinger, H.; Dolley, P.; Ogilvie, S.; et al. *Preparatory Study on Food Waste Across EU 27*; European Commission: Brussels, Belgium, 2011; Volume 33, p. 17, doi:10.2779/85947.
11. Stenmarck, Å.; Jensen, C.; Quested, T.; Moates, G. *Fusions: Estimates of European Food Waste Levels*; IVL Swedish Environmental Research Institute, Stockholm, Sweden, 2016; ISBN 9789188319012.
12. Koivupuro, H.-K.; Hartikainen, H.; Silvennoinen, K.; Katajajuuri, J.-M.; Heikintalo, N.; Reinikainen, A.; Jalkanen, L. Influence of socio-demographical, behavioural and attitudinal factors on the amount of avoidable food waste generated in Finnish households. *Int. J. Consum. Stud.* **2012**, *36*, 183–191, doi:10.1111/j.1470-6431.2011.01080.x.
13. Abeliotis, K.; Lasaridi, K.; Chroni, C. Attitudes and behaviour of Greek households regarding food waste prevention. *Waste Manag. Res.* **2014**, *32*, 237–240, doi:10.1177/0734242X14521681.
14. Giordano, C.; Piras, S.; Boschini, M.; Falasconi, L. Are questionnaires a reliable method to measure food waste? A pilot study on Italian households. *Br. Food J.* **2018**, *120*, 2885–2897, doi:10.1108/BFJ-02-2018-0081.
15. Falasconi, L.; Cicatiello, C.; Franco, S.; Segrè, A.; Setti, M.; Vittuari, M. Such a shame! A study on self-

- perception of household food waste. *Sustainability* **2019**, *11*, 12–20, doi:10.3390/su11010270.
16. Setti, M.; Banchelli, F.; Falasconi, L.; Segrè, A.; Vittuari, M. Consumers' food cycle and household waste. When behaviors matter. *J. Clean. Prod.* **2018**, *185*, 694–706, doi:10.1016/j.jclepro.2018.03.024.
  17. Parizeau, K.; von Massow, M.; Martin, R. Household-level dynamics of food waste production and related beliefs, attitudes, and behaviours in Guelph, Ontario. *Waste Manag.* **2015**, *35*, 207–217, doi:10.1016/j.wasman.2014.09.019.
  18. Quested, T.; Luzecka, P. *Household Food and Drink Waste: A People Focus*; WRAP: Banbury, UK, 2014.
  19. Wenlock, R.W.; Buss, D.H. Wastage of edible food in the home: A preliminary study. *J. Hum. Nutr.* **1977**, *31*, 405–11.
  20. Møller, H.; Hanssen, O.J.; Gustavsson, J.; Östergren, K.; Stenmarck, Å.; Dekhtyar, P. *Report on Review of (Food) Waste Reporting Methodology and Practice*; Reducing food waste through social innovation—Fusions; Ostfold Research: Kråkerøy, Norway, 2014.
  21. Van Herpen, E.; van der Lans, I.; Holthuysen, N.; Nijenhuis-de Vries, M.; Quested, T.E. Comparing wasted apples and oranges: An assessment of methods to measure household food waste. *Waste Manag.* **2019**, *88*, 71–84, doi:10.1016/j.wasman.2019.03.013.
  22. Reynolds, C.; Goucher, L.; Quested, T.; Bromley, S.; Gillick, S.; Wells, V.K.; Evans, D.; Koh, L.; Carlsson Kanyama, A.; Katzeff, C.; et al. Review: Consumption-stage food waste reduction interventions—What works and how to design better interventions. *Food Policy* **2019**, *83*, 7–27, doi:10.1016/j.foodpol.2019.01.009.
  23. Elimelech, E.; Ayalon, O.; Ert, E. What gets measured gets managed: A new method of measuring household food waste. *Waste Manag.* **2018**, *76*, 68–81, doi:10.1016/j.wasman.2018.03.031.
  24. Giordano, C.; Alboni, F.; Falasconi, L.; Quantities, Determinants, and Awareness of Households' Food Waste in Italy: A Comparison between Diary and Questionnaires Quantities'. *Sustainability* **2019**, *11*, 3381, doi:10.3390/su11123381.
  25. Barone, A.M.; Grappi, S.; Romani, S. "The road to food waste is paved with good intentions": When consumers' goals inhibit the minimization of household food waste. *Resour. Conserv. Recycl.* **2019**, *149*, 97–105, doi:10.1016/j.resconrec.2019.05.037.
  26. Thyberg, K.L.; Tonjes, D.J. Drivers of food waste and their implications for sustainable policy development. *Resour. Conserv. Recycl.* **2016**, *106*, 110–123, doi:10.1016/j.resconrec.2015.11.016.
  27. Ajzen, I. Consumer attitudes and behavior: The theory of planned behavior applied to food consumption decisions. *Rivista di Economia Agraria* **2015**, *70*, 121–138, doi:10.13128/REA-18003.
  28. Ajzen, I. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* **1991**, *50*, 179–211, doi:10.1016/0749-5978(91)90020-T.
  29. Visschers, V.H.M.; Wickli, N.; Siegrist, M. Sorting out food waste behaviour: A survey on the motivators and barriers of self-reported amounts of food waste in households. *J. Environ. Psychol.* **2016**, *45*, 66–78, doi:10.1016/j.jenvp.2015.11.007.
  30. MacInnis, D.J.; Moorman, C.; Jaworski, B.J. Enhancing and Measuring Consumers' Motivation, Opportunity, and Ability to Process Brand Information from Ads. *J. Mark.* **1991**, *55*, 32, doi:10.2307/1251955.
  31. Rothschild, M.L. Carrots, Sticks, and Promises: A Conceptual Framework for the Management of Public Health and Social Issue Behaviors. *J. Mark.* **1999**, *63*, 24, doi:10.2307/1251972.
  32. Van Geffen, L.; Van Herpen, E.; Van Trijp, H. Causes & Determinants of Consumers Food Waste. [https://eu-refresh.org/sites/default/files/Causes%20%26%20Determinants%20of%20Consumers%20Food%20Waste\\_0.pdf](https://eu-refresh.org/sites/default/files/Causes%20%26%20Determinants%20of%20Consumers%20Food%20Waste_0.pdf) (accessed date: 24 April 2020)
  33. Stancu, V.; Haugaard, P.; Lähteenmäki, L. Determinants of consumer food waste behaviour: Two routes to food waste. *Appetite* **2016**, *96*, 7–17, doi:10.1016/j.appet.2015.08.025.
  34. Ajzen, I. Perceived Behavioral Control, Self-Efficacy, Locus of Control, and the Theory of Planned Behavior. *J. Appl. Soc. Psychol.* **2002**, *665*–683, doi:10.1111/j.1559-1816.2002.tb00236.x.
  35. Lapinski, M.K.; Rimal, R.N. An Explication of Social Norms. *Commun. Theory* **2005**, *127*–147, doi:10.1111/j.1468-2885.2005.tb00329.x.
  36. Cialdini, R.B.; Kallgren, C.A.; Reno, R.R. A focus theory of normative conduct: A theoretical refinement and reevaluation of the role of norms in human behavior. *Adv. Exp. Soc. Psychol.* **1991**, *24*, 201–234.
  37. Van Geffen, L.; van Herpen, E.; Sijtsema, S.; van Trijp, H. Food waste as the consequence of competing motivations, lack of opportunities, and insufficient abilities. *Resour. Conserv. Recycl. X* **2020**, *5*, 100026, doi:10.1016/j.rcrx.2019.100026.
  38. Darnton, A.; David, E. *Influencing Behaviours—A Technical Guide to the ISM Tool*; Scottish Government:

- Edinburgh, UK, 2013.
39. Shwom, R.; Lorenzen, J.A. Changing household consumption to address climate change: Social scientific insights and challenges. *WIREs Clim. Change* **2012**, doi:10.1002/wcc.182.
  40. Graham-Rowe, E.; Jessop, D.C.; Sparks, P. Identifying motivations and barriers to minimising household food waste. *Resour. Conserv. Recycl.* **2014**, *84*, 15–23, doi:10.1016/j.resconrec.2013.12.005.
  41. Philippidis, G.; Sartori, M.; Ferrari, E.; M'Barek, R. Waste not, want not: A bio-economic impact assessment of household food waste reductions in the EU. *Resour. Conserv. Recycl.* **2019**, *146*, 514–522, doi:10.1016/j.resconrec.2019.04.016.
  42. Richter, B. Knowledge and perception of food waste among German consumers. *J. Clean. Prod.* **2017**, *166*, 641–648, doi:10.1016/j.jclepro.2017.08.009.
  43. Mourad, M. Recycling, recovering and preventing “food waste”: Competing solutions for food systems sustainability in the United States and France. *J. Clean. Prod.* **2016**, *126*, 461–477, doi:10.1016/j.jclepro.2016.03.084.
  44. Knezevic, B.; Kurnoga, N.; Anic, I.-D. Typology of university students regarding attitudes towards food waste. *Br. Food J.* **2019**, *121*, 2578–2591, doi:10.1108/BFJ-05-2018-0316.
  45. Qi, D.; Roe, B.E. Household Food Waste: Multivariate Regression and Principal Components Analyses of Awareness and Attitudes among U.S. Consumers. *PLoS ONE* **2016**, *11*, e0159250, doi:10.1371/journal.pone.0159250.
  46. Setti, M.; Falasconi, L.; Segrè, A.; Cusano, I.; Vittuari, M. Italian consumers' income and food waste behavior. *Br. Food J.* **2016**, *118*, 1731–1746, doi:10.1108/BFJ-11-2015-0427.
  47. Tucker, C.A.; Farrelly, T. Household food waste: The implications of consumer choice in food from purchase to disposal. *Local Environ.* **2016**, *21*, 682–706, doi:10.1080/13549839.2015.1015972.
  48. Rutten, M.; Nowicki, P.; Bogaart, M.-J.; Aramyan, L. *Reducing Food Waste by Households and in Retail in the EU*; LEI, part of Wageningen UR: Hague, The Netherlands, 2013; ISBN 9789086156535.
  49. George, R.M.; Burgess, P.J.; Thorn, R.D. *Reducing Food Waste through the Chill Chain*; WRAP: Banbury, UK, 2010; 1–95.
  50. Díaz-Ruiz, R.; Costa-Font, M.; Gil, J.M. *A Social Perspective on Food Waste: To What Extent Consumers Are Aware of Their Own Food Waste*; Wageningen Academic Publishers: The Netherlands, 2015; pp. 157–164.
  51. Johnson, D.; Hipps, N.; Hails, S. *Food Waste Helping Consumers Reduce Fruit and Vegetable Waste*; WRAP: Banbury, UK, 2008.
  52. Pearson, D.; Miroso, M.; Andrews, L.; Kerr, G. Reframing communications that encourage individuals to reduce food waste. *Commun. Res. Pract.* **2017**, *3*, 137–154, doi:10.1080/22041451.2016.1209274.
  53. Neff, R.A.; Spiker, M.; Rice, C.; Schklair, A.; Greenberg, S.; Leib, E.B. Misunderstood food date labels and reported food discards: A survey of U.S. consumer attitudes and behaviors. *Waste Manag.* **2019**, *86*, 123–132, doi:10.1016/j.WASMAN.2019.01.023.
  54. Queded, T.; Johnson, H. *Household Food and Drink Waste in the UK: Final Report*; WRAP: Banbury, UK, 2012; ISBN 9781844054589.
  55. Queded, T.E.; Marsh, E.; Stunell, D.; Parry, A.D. Spaghetti soup: The complex world of food waste behaviours. *Resour. Conserv. Recycl.* **2013**, *79*, 43–51, doi:10.1016/j.resconrec.2013.04.011.
  56. Van Garde, S.J.; Woodburn, M.J. Food discard practices of householders. *J. Am. Diet. Assoc.* **1987**, *87*, 322–9.
  57. WRAP. *Investigation into the Possible Impact of Promotions on Food Waste*; WRAP: Banbury, UK, 2011.
  58. Secondi, L. Expiry Dates, Consumer Behavior, and Food Waste: How Would Italian Consumers React If There Were No Longer “Best Before” Labels? *Sustainability* **2019**, *11*, 6821, doi:10.3390/su11236821.
  59. Principato, L.; Secondi, L.; Pratesi, C.A. Reducing food waste: An investigation on the behaviour of Italian youths. *Br. Food J.* **2015**, *117*, 731–748, doi:10.1108/BFJ-10-2013-0314.
  60. Silvennoinen, K.; Katajajuuri, J.M.; Hartikainen, H.; Jalkanen, L.; Koivupuro, H.K.; Reinikainen, A. Food waste volume and composition in the Finnish supply chain: Special focus on food service sector. *Br. Food J.* **2012**, 12–15, doi:10.1108/BFJ-12-2012-0311.
  61. WRAP.; French-Brooks, J.; *Reducing Supply Chain and Consumer Potato Waste*; WRAP: Banbury, UK, 2012; pp. 10–47.
  62. Glanz, R. Causes of food waste generation in households an empirical analysis. Master's Thesis, University of Natural Resources and Applied Life Sciences, Vienna and Cranfield University, 2008.
  63. Grainger, M.J.; Aramyan, L.; Piras, S.; Queded, T.E.; Righi, S.; Setti, M.; Vittuari, M.; Stewart, G.B. Model selection and averaging in the assessment of the drivers of household food waste to reduce the probability

- of false positives. *PLoS ONE* **2018**, *13*, e0192075, doi:10.1371/journal.pone.0192075.
64. Aschemann-Witzel, J.; Giménez, A.; Ares, G. Convenience or price orientation? Consumer characteristics influencing food waste behaviour in the context of an emerging country and the impact on future sustainability of the global food sector. *Glob. Environ. Change* **2018**, doi:10.1016/j.gloenvcha.2018.02.002.
  65. Delley, M.; Brunner, T.A. Foodwaste within Swiss households: A segmentation of the population and suggestions for preventive measures. *Resour. Conserv. Recycl.* **2017**, *122*, 172–184, doi:10.1016/j.resconrec.2017.02.008.
  66. Gaiani, S.; Caldeira, S.; Adorno, V.; Segrè, A.; Vittuari, M. Food wasters: Profiling consumers' attitude to waste food in Italy. *Waste Manag.* **2018**, *72*, 17–24, doi:10.1016/j.wasman.2017.11.012.
  67. Annunziata, A.; Agovino, M.; Ferraro, A.; Mariani, A. Household Food Waste: A Case Study in Southern Italy. *Sustainability* **2020**, *12*, 1495, doi:10.3390/su12041495.
  68. Di Talia, E.; Simeone, M.; Scarpato, D. Consumer behaviour types in household food waste. *J. Clean. Prod.* **2019**, *214*, 166–172, doi:10.1016/J.JCLEPRO.2018.12.216.
  69. Welch, D.; Swaffield, J.; Evans, D. Who's responsible for food waste? Consumers, retailers and the food waste discourse coalition in the United Kingdom. *J. Consum. Cult.* **2018**, doi:10.1177/1469540518773801.
  70. WRAP *Food Behaviour Consumer Research: Quantitative Phase*; WRAP: Banbury, UK, 2007.
  71. Bolos, L.A.; Lagerkvist, C.J.; Nayga, R.M. Consumer Choice and Food Waste : Can Nudging Help? *Choices* **2019**, *34*, 1–7.
  72. De Hooge, I.E.; Oostindjer, M.; Aschemann-Witzel, J.; Normann, A.; Loose, S.M.; Almlí, V.L. This apple is too ugly for me! *Food Qual. Prefer.* **2017**, *56*, 80–92, doi:10.1016/j.foodqual.2016.09.012.
  73. Romani, S.; Grappi, S.; Bagozzi, R.P.; Barone, A.M. Domestic food practices: A study of food management behaviors and the role of food preparation planning in reducing waste. *Appetite* **2018**, *121*, 215–227, doi:10.1016/J.APPET.2017.11.093.
  74. Richter, B.; Bokelmann, W. Explorative study about the analysis of storing, purchasing and wasting food by using household diaries. *Resour. Conserv. Recycl.* **2017**, *125*, 181–187, doi:10.1016/j.resconrec.2017.06.006.
  75. Wolsink, M. Entanglement of Interests and Motives: Assumptions behind the NIMBY-theory on Facility Siting. *Urban Stud.* **1994**, *31*, 851–866, doi:10.1080/00420989420080711.



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