Consumer Choice and Food Waste: A Demand-Side Perspective to Address the Challenge of Sustainable Consumption Models

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1. Introduction

Food waste (FW) is a global problem whose political and social importance has grown in recent years (Corrado et al. 2019), which is why its reduction has been included within the Sustainable Development Goals of the UN Agenda 2030 in its 12th goal "Ensure sustainable consumption and production patterns" with the aim of halving per capita overall food waste at both retail and consumer levels and of reducing losses of food throughout production and food supply chains (FSCs) including post-harvest losses, by 2030 (UNDP 2016).

Although there is not yet a single methodology to measure it, and the accessible data are different, current estimates indicate that globally about a third of food produced for human consumption is wasted or lost (Gustavsson et al. 2011). Food is a precious commodity and its production requires many resources. The overall cost of FW amounts to about 2.6 trillion US dollars a year if we consider the economic, environmental and social costs associated with it (FAO 2013).

Food losses, meaning the waste that happens in the first phases of the FSC, are mainly an issue in developing countries due to a lack of investments and inadequate infrastructures. Meanwhile, FW, the waste that occurs at the retail and consumption level is a typical problem of western countries and happens as a result of consumer's specific behavioral issues and habits (Gustavsson et al. 2011; Parfitt et al. 2010; Secondi et al. 2015; Principato 2018).

Considering the waste per type of food, the Food and Agriculture Organization (FAO) estimates that, globally, up to 30% of cereals, 20% of dairy, 35% of fish and seafood, 45% of fruits and vegetables, 20% of meat, 20% of oilseeds and pulses, and 45% of roots and tubers get lost or are wasted along the FSC (Gustavsson et al. 2011). According to research conducted in Italy (Waste Watchers 2017), if we consider the wasted food within the household, we waste 31% of fruit and 29% of salad (29%), followed by other vegetables (19%), bread (17%), cold cuts (16%), cheese and dairy

products (respectively 16% and 14%). Scrolling down the list we find yogurt (12%), milk (10%), cooked pasta (9%), cooked meat (7%) and raw meat (6%). At the end of the list are other foods (like eggs and sauces) (5%), and desserts (4%).

In terms of socio-economic status, as acknowledged by Principato (2018), the literature debate is still open. Indeed, if we consider the level of education of individuals, the more educated they are, the higher the quantities of wasted food (Visschers et al. 2016; Secondi et al. 2015). Household composition also plays a role: bigger households tend to waste more than smaller ones (Quested et al. 2013), although it has been seen that the amount of FW per capita decreases as the members of a family increase (Parizeau et al. 2015). In any case, it has been seen that families with children tend to waste more than all-adult households of the same size because of picky eating and food safety (Quested and Luzecka 2014). Considering gender, some researches showed that females waste more than males (Visschers et al. 2016); however, a number of other studies revealed that men waste more than women (Gallo 1980; Buzby and Guthrie 2002). In terms of income, most of the findings suggest that higher-income households waste more than those with lower-incomes (Buzby and Guthrie 2002; Van Garde and Woodburn 1987; Osner 1982; Koivupuro et al. 2012; Stefan et al. 2013). On the other hand, some demonstrated the opposite (Stefan et al. 2013; Cox and Downing 2007; Thi Thuy Trang et al. 2017).

The purpose of this study is to investigate—from the demand side—consumers' choice in terms of wasted (edible and not consumed) food at the domestic level. Through data collected on a sample of consumers in Italy, this research aims to: (i) analyze types of food most wasted at the household level, according to socio-economic characteristics of families; and (ii) evaluate, by means of the Working–Leser (WL) demand equation models, if and to what extent propensity and responsiveness to wasted food vary according to both weekly expenditure for food and household living standards as measured by total annual household income.

To our knowledge, studying the connection between FW generation and demand elasticity represents a new and original approach for addressing consumer behavior towards FW. The results obtained provide new data on food purchasing behavior and the FW phenomenon at the consumer level, thus a novel contribution to ensuring sustainable consumption patterns.

The remainder of the chapter is structured as follows: Section 2 describes the data collection process and the methodological approach used for the estimation of consumers' elasticity towards FW. Section 3 reports the obtained results both in terms of descriptive analysis and estimated elasticity. Section 4 provides a discussion

starting from the results obtained by highlighting the possible contributions of this study to the literature and to the possible uses by policy makers. In the same section, some concluding remarks are drawn by focusing on further development of the research.

2. Materials and Methods

2.1. The Data Collection Process

In order to obtain information on the FW produced and, specifically, on the categories of food (types of food) wasted by households, as well as their distribution in the overall generated FW, an ad-hoc questionnaire was implemented and structured with the following six sections: (i) knowledge of the phenomenon of FW in terms of dissemination and awareness of the economic, social and environmental impacts of FW (questions with a Likert response scale); (ii) behavior and purchasing habits in terms of the overall weekly food expenditure, frequency, and type of distribution channel generally chosen for the purchase of food; (iii) FW behavior and habits in terms of distribution among different categories of food, meal planning, methods for reducing waste, and reasons for which FW is generated in the family; (iv) awareness of FW behaviors by means of a set of questions regarding, for example, the influence of the aesthetic aspect of food or the offers and disposition of food in supermarkets on the family; (v) preventive actions that would reduce food waste, such as, for example, greater awareness of the meanings of product labels or availability in stores of packages with less food (set of questions with Likert-type answer); (vi) socio-demographic characteristics of the head of household responsible for purchases (specifically her/his gender, age, level of education, marital status, and residence) as well as her/his family characteristics in terms of overall economic situation (household living standard as measured by the declared total annual income), number of family members and presence of children within the nucleus.

The core questions of the questionnaire, contained in Section 3—and on which the analyses reported below are based—focus on the distribution of FW (in percentages) among the following categories of food: (i) pasta, rice and cereals; (ii) meat and cured meat; (iii) vegetables and legumes; (iv) fruit; (v) bread and pizza; (vi) cheese and eggs; (vii) fish and derived products; (viii) milk, yogurt and other dairy products; (ix): sauces and condiments; (x) sweets and desserts.

The data were collected in the period October 2017–January 2018 from a sample of respondents located mainly in the Lazio and Tuscany regions. The adopted sampling scheme started with the voluntary participation of university students

who were asked to involve their families in the filling out of the questionnaire and, specifically, to involve the family member responsible for food purchases.

Once they agreed, the questionnaire could be accessed through a Web Based Survey (WBS) system characterized by a self-administration of the responses by the participants. By adopting this procedure, we obtained answers from 268 families (as represented by the household member responsible for food purchase) whose controlled and validated responses were considered for the descriptive analyses and statistical modeling reported in the following sections.

2.2. The Demand Modeling Estimation Approach

The empirical model applied to study the propensity of consumers towards FW and, therefore, their responsiveness to FW with regards to both total food expenditure and household living standards is the WL model, introduced by Working (Working 1943) and Leser (Leser 1963) and further developed by Deaton and Muellbauer (Deaton and Muellbauer 1980a, 1980b), as presented in the general Equation (1). This model was used to estimate the food waste expenditure elasticity (hereon FWE2) with reference to the 10 categories of food presented in the previous section.

The basic equation of the WL model is presented in a log-linear form in which the share of waste of each food product is a linear function of the logarithm of prices and the logarithm of total weekly expenditure of all the foods considered. In our study, the socio-demographic characteristics of households were also considered as control factors. Therefore, the single estimated equation can be expressed as:

$$w_{in} = \alpha_{0i} + \alpha_i \log x_n + \beta_i \log p_i + \sum_{j \neq i} \beta_j \log p_j + \sum_k \gamma_{kj} H_{kn} + \varepsilon_{in} \quad (1)$$

where i ($i = 1, \ldots 10$) represents the index of the product category considered for the estimation, while n ($n = 1, \ldots 268$) refers to the n-th family considered. In Equation (1) w_{in} represents the share of FW generated for the i-th product category by the n-th family, x_n represents the average weekly expenditure for food, while p_i represents the price of the products of the i-th studied category and $\mathrm{p_j}$ the prices of the other products (for $i \neq j$). Furthermore, $\mathrm{H_{kn}}$ represents the k-th ($k = 1, \ldots K$) socio-demographic characteristic of the n-th family introduced as a control factor in the estimated regression models. Lastly, ε_{in} is the error component of the model.

As underlined by Landry and Smith (2019) who used the WL specification for the overall estimation of FW elasticity in the context of the Household Food Consumption Survey for US households, the advantage of the WL specification is that it suits utility-maximization with the assumption of constant returns to scale

and separability, and that it is possible to calculate expenditure elasticity consistent with consumer theory.

It is worth noting that the WL specification in its log-linear form does not give a direct interpretation of expenditure elasticity. Therefore, the FW expenditure elasticity (FWE2) for the i-th product category can be obtained from the parameter estimates as:

$$\text{FWE2}_i = 1 + \left(\frac{\alpha_i}{w_i}\right) \tag{2}$$

whose computed value according to whether it is less than, equal to, or greater than 1, can provide indications of the lower or higher sensitivity of consumers to FW as their weekly food expenditure increases. In this sense, values of FWE2 less than (or greater than) the unit—which, in the classic consumer microeconomic approach, provide references for necessary goods or luxury goods—provide information on the speed with which FW grows with overall increasing expenditure on food. Therefore, it provides evidence of less or more tendency to throw away food when food expenditure increases.

In estimating the equations reported in the general form in Equation (1), the different household living standards of the respondents were taken into account by considering the estimate of two separate sets of equations based on the answers provided by the participants in the survey regarding total annual family income. Since the questionnaire includes information about classes of total annual income, the median category (total family income between 15 and 25 thousand Euros) was considered to have two subgroups of households—defined as households with a low-medium level of income and household with a high level of income—by which to investigate the propensity and tendencies towards FW.

With reference to the variables considered, food expenditure (x_i) refers to the average household expenditure incurred weekly for the purchase of food. Considering the price vector $\mathbf{p}$ (i = 1, ... 10) we referred to the average published prices of the various categories of products by the Price Observatory of the Italian Ministry of Economic Development and referred to the month during which the interview was conducted.

As regards the socio-economic characteristics considered, the following variables were introduced in the WL specification: head of the family gender, age, marital status, and educational qualification, as well as information about the nuclear family in terms of number of family members, presence of children, and residence area (also by distinguishing between rural and urban areas).

3. Results

3.1. A Descriptive Analysis: Respondents and Their Purchase Habits

The sample of respondents was composed of 268 individuals, aged between 18 and 69 with family compositions ranging from one to seven people. It emerged that the task of food supply is carried out by majority women (81%), and the remaining part by men (19%). A total of 80.96% of individuals were domiciled in the Lazio region while 19.04% of respondents resided in Tuscany.

The average weekly expenditure for the purchase of food incurred by households was approximately EUR 98.77 (standard deviation equal to 66.55), with empirical quartiles observed at $Q_1 = 50$, $Q_2 = 85$ and $Q_3 = 125$ Euros.

The supermarket was the most cited place to purchase food (222 responses out of 268 respondents equal to a percentage value of 82.84%). Indeed, respondents were asked to indicate the two places their family generally makes food purchases and the second most frequently cited purchase location was a small retail store (117 out of 268 respondents, corresponding to 43.66%). Discount (69 respondents) and hypermarkets (56 respondents with a total incidence percentage of 20.9% of respondents) followed, as reported in Figure 1. It should be noted that the percentages in Figure 1 do not sum 100 because respondents could choose at most two places where food shopping was carried out. Therefore, for each place of purchase, the percentage indicates the proportion of individuals that used this channel independently to the preference order and to the total number of places selected.

Regarding the frequency of purchases, "two/three times per week" was the modal category observed for the respondents (approximately 51.1%) followed by "once a week" (26.5%), while 18.9% declared to purchase food "every day".

Regarding the FW generated, about 88% of the sample claimed to throw away less than 15% of food purchased and not consumed weekly, while only 1.5% threw out more than 30% of food weekly.

3.2. FW by Categories, the WL Model Estimation and the Obtained FWE2

The three most wasted types of food (referring to the specific food category) were fruit (18.15%), vegetables and legumes (16.54%) and bread and pizza (16.38%), as shown in Figure 2, thus confirming the ranking published by the Waste Watcher (Lmm/Swg) observatory regarding to the most wasted foods in Italy in 2016. The categories least subject to be wasted were sweets (3.91%) and fish (3.52%).

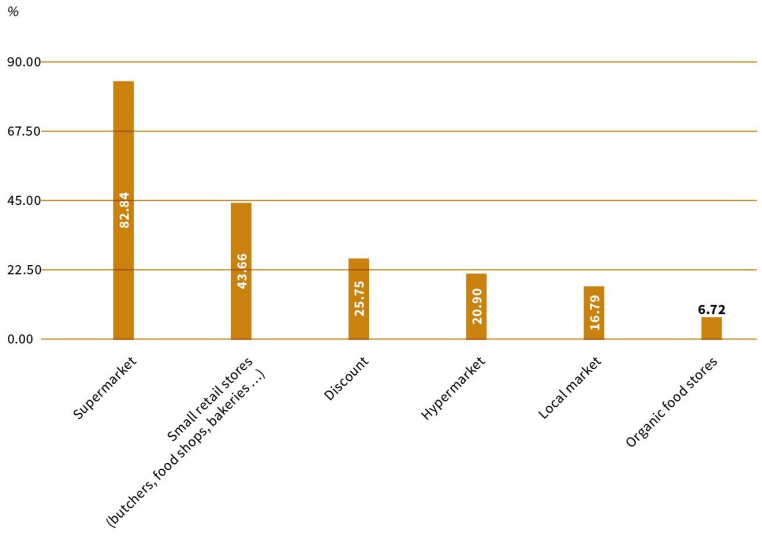

Figure 1. Places where food shopping is usually carried out (note: multiple choice question). Source: Own illustration.

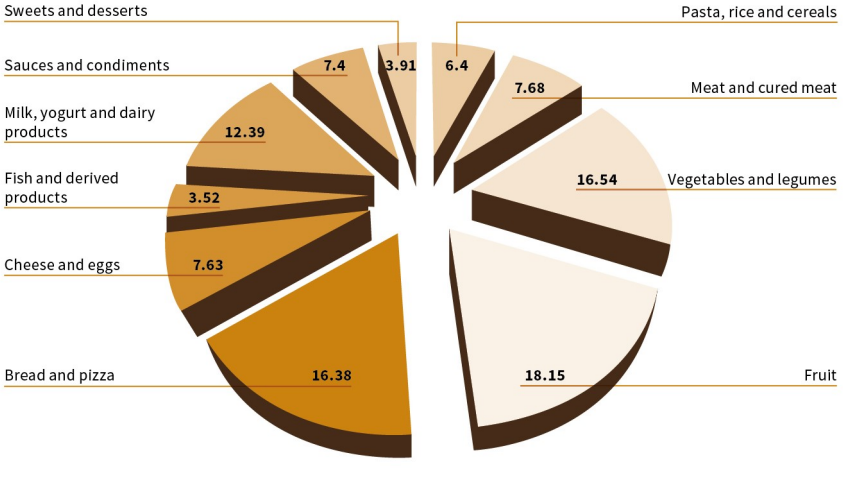

Figure 2. Food waste (FW) distribution across the 10 studied categories. Source: Own illustration.

On the other hand, Figure 3 shows, for each food category, the empirical overall distribution of responses thus highlighting both the range (in terms of minimum

and maximum observed values) and the mid-range variability as measured by the dispersion between first and third quartiles.

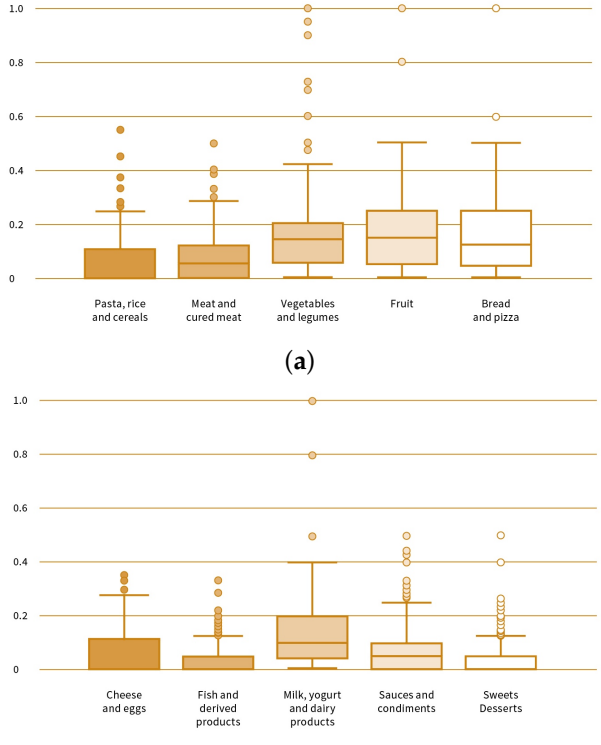

Figure 3. Box-plot of FW per food category: (**a**) pasta, rice and cereals; meat and cured meat; vegetables and legumes; fruit; bread and pizza; (**b**): cheese and eggs; fish and derived products; milk, yogurt and dairy products; sauce and condiments; sweets and desserts. Source: Own illustration.

In order to understand any differences in the propensity to waste food according to the total expenditure and households' standard of living, we estimated the WL model by distinguishing families according to the median household income declared in the interview. Aware of the bias that a declared income could generate, the goal was to understand if and to what extent there were differences in the propensity to waste between households whose income was less than 25 thousand Euros (this category represents the median category based on respondents) and households with an annual income of 25 thousand Euros or more.

We estimated two different subsets of FW share equations based on the specification proposed in Equation (1). Figure 4 shows the values of the FWE2 for the two groups of families and highlighted a cut-off of 1, which distinguishes the level of growth of FW as less proportional (if the elasticity is less than 1) or more than proportional (if the elasticity is greater than 1) as the overall weekly spending increases.

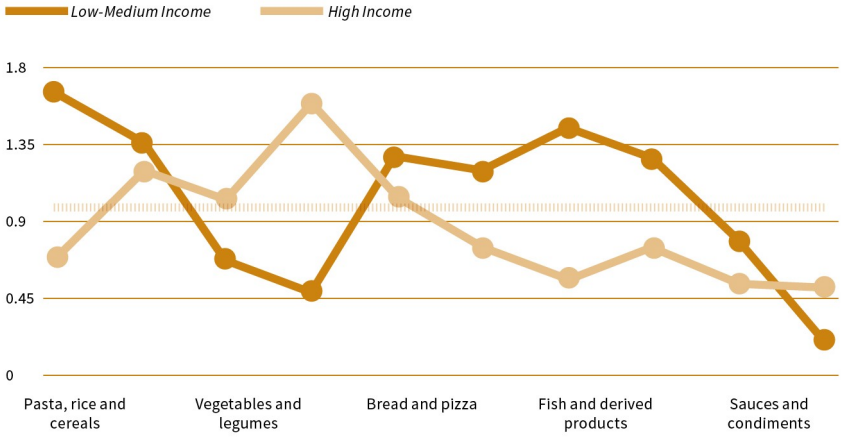

Figure 4. Food waste expenditure elasticity (FWE2) for the studied food categories: values of the FW expenditure elasticity distinguished for low–medium and high household incomes (red line equal to 1 for the distinction between necessary and luxury food categories). Source: Own illustration

Table 1 shows the estimates of the parameters (with the related level of statistical significance) used for the computation of FW expenditure elasticity.

The elasticities were computed—according to Equation (2)—by considering the average share of the i-th food category.

As usual in microeconomic theory of elasticities, at first evaluation of the elasticity values it was noted that all estimated elasticities were positive, proving that all the categories of products considered represented "normal goods" towards FW. Therefore, these were categories of products, for which as food expenditure increases the quantity (in percentage) of FW increases. If, on the other hand, we had obtained negative values of FWE2, we would have found ourselves faced with "lower goods", for which as spending increased the amount of FW produced would have decreased (Varian 2002).

Table 1. Working–Leser parameter and FWE2 estimates.

	LOW-INCOME			MEDIUM-HIGH INCOME		
	Alpha	Significance Level	FWE2	Alpha	Significance Level	FWE2
Pasta, rice and cereals	−0.018		0.711	0.043	**	1.647
Meat and cured meat	0.014		1.197	0.030	*	1.369
Vegetables and legumes	0.007		1.038	−0.047	*	0.665
Fruit	0.103	***	1.598	−0.097	***	0.491
Bread and pizza	0.008		1.048	0.047		1.284
Cheese and eggs	−0.019		0.745	0.015		1.200
Fish and derived products	−0.016		0.583	0.014		1.456
Milk, yogurt and dairy products	−0.025		0.764	0.041		1.285
Sauces and condiments	−0.036	**	0.538	−0.015		0.789
Sweets and desserts	−0.019		0.529	−0.031	**	0.202

Notes: * p-value < 0.10; ** p-value < 0.05; *** p-value < 0.01. Source: Own data.

For some categories of goods, values of elasticity higher than one were observed. In this sense, for the usual so-called luxury goods, FW increased more than proportionally compared to the increase in food expenditure.

By combining the elasticity values with the relative significance levels, and also by considering the distinction between household living standards (low-medium and high levels of income), we noticed elasticity values higher than the unit for fruit (p-value < 0.01) in the low-income households. Therefore, by an increase of 1 percentage point of food expenditure, the value of FW for fruit increased by 1.5 percentage points. On the contrary, elasticity, statistically significant and lower than 1, was observed for sauces and condiments (p-value < 0.05), meaning that as spending increased there was a tendency to observe a less than proportional increase in the waste of this category of products.

Considering families with medium-high income, we noted values of elasticity higher than the unit for pasta, rice and cereals (p-value < 0.05), meat and cured meat (p-value < 0.10) indicating that these foods were considered "luxury goods" and, therefore, their waste increased disproportionately to the expense. On the other hand, FWE2 values lower than unity—which showed a less than proportional growth in FW compared to overall food expenditure—were observed for vegetables and legumes (p-value < 0.10), fruit (p-value < 0.01) and for sweets and dessert (p-value < 0.05).

4. Discussion and Conclusions

Much has been written about FW at the domestic level in recent years, focusing attention on consumer awareness of the impacts of FW, the causes of FW and the measures to be implemented in order to be able to reduce FW in practice to achieve the 2030 objective set by SDG 12—to halve FW (Corrado et al. 2019; Gustavsson et al. 2011; Secondi et al. 2015; Waste Watchers 2017; Quested et al. 2013; Koivupuro et al. 2012; Mondéjar-Jiménez et al. 2016; Principato et al. 2015; Secondi 2019).

In this study, we attempted to address a new perspective of analysis to understand—given the centrality of the role of FW in the entire production chain (Principato et al. 2019; Secondi et al. 2019a) and the possibilities of FW recovery within a circular economy perspective—the propensity of consumers towards FW and, in particular, to understand if and to what extent this propensity varied for different categories of products and household living standards. To answer this research question, a topic on which literature is right now emerging, we started an exploratory investigation involving a sample of Italian families located mainly in the Lazio region and southern Tuscany. We made an effort to have the person in charge of family purchases be directly involvedin logging the percentage of FW for 10 categories of products (the sum of these categories was required to be 100%). The collected data were then analyzed within the perspective of consumer FW demand and in terms of FW expenditure elasticity (for which we introduced the acronym FWE2) which, like the classical elasticity with respect to expenditure (expenditure elasticity) enables analysts and researchers to provide information with greater or lesser proportional growth in FW generation in relation to the expenditure.

In order to highlight behavioral differences, we distinguished the families interviewed on the basis of their standard of living and estimated two separate WL type equations. This allowed us, in the first stage of research, to estimate two separate FWE2s distinguished by level of total household income and, therefore, to obtain a different level of households responsiveness in generating FW, according to the amount spent on food. It is important to emphasize that the computed elasticity reflects the elasticity of producing FW and is not directed towards "consumer goods", as they usually are. This evidence can be the starting point for a deep reflection concerning economic meaning and interpretation.

This first exploratory analysis produced interesting results for the discussion. First of all, for all categories of food we obtained a positive elasticity value, thus confirming these products as normal goods for which FW varies in a positive sense as spending increases. This result is in line with the one recently observed for the

U.S. by Landry and Smith (2019), where FW was considered for luxury goods with values between 1.1 and 1.4.

In this regard, and by distinguishing positive values lower (or greater) than unit in order to identify necessary (or luxury) categories of food, we noted the presence of goods considered "luxury food" for a group of families, while necessity goods for others. This is the case, for example, with fruit. In fact, if fruit represents a "luxury food" for the generation of FW for low-medium income families, the waste grows more than proportionally with respect to expenditure. For families with a higher level of income, the wasted food of this category grows less than proportionally. The result obtained must certainly be investigated further, but in our opinion can be related to both the promotional offer, which leads consumers (above all, consumers with a low-medium level of income) to purchase quantities of food (in this case fruit) that they will not be able to consume in time (before their physiological drop) as well as to the importance of linking FW generation with a nutritional balanced and correct diet by consumers. Distinctly, higher income families also buy and consume more fruit but, in their diet—as is the case for the Mediterranean diet, for example—such fruits (and vegetables) are actually consumed and therefore wasted to a lesser extent. As a result, it is also important, at the policy level, to jointly address the issue of food well-being and health, thus helping the dissemination of good food practices (consumption of fruit and vegetables for example) as well as helping low-income families guarantee a balanced diet. from a nutritional point of view, which may require greater economic effort (Benedetti et al. 2018).

From this perspective, the estimates of demand elasticities for commodity groups and household characteristics can help with planned interventions aimed at addressing selected categories of consumers, thus contributing to minimized FW, sustainable consumption models and the ultimate reduction of FW related impacts. In this sense, a method to reduce fruit waste would be to implement targeted consumer educational campaigns on fruit consumption that emphasize the role of fruit in pursuing our health and well-being, and at the same time bring attention to perishability so that clusters, like the low-income population, buy the correct daily amount. For these interventions, digital innovations and applications could be of use (Secondi et al. 2019b) in achieving the desired results more effectively.

Further research must be carried out on the implementation of more flexible demand equation systems (such as the Almost Ideal Demand System) as well as with more structured survey methods (i.e., a larger sample survey on a representative sample of Italian consumers), which would enable academics and, therefore, policy makers to analyze this vital issue with a deeper, more detailed, and targeted approach.

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