



Full length article

# Foodwaste within Swiss households: A segmentation of the population and suggestions for preventive measures



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## ABSTRACT

The aim of this study was to better understand the attitudes, perceptions and behaviours of the Swiss towards the food waste generated within their households and to provide suggestions of targeted measures to tackle the problem effectively. Data were collected through a postal survey sent out to a randomly selected sample of 3834 German- and French-speaking Swiss residents, yielding a final sample size of  $N = 681$ . A cluster analysis resulted in the identification of six distinct consumer groups: the conservative (23.9%), the self-indulgent (7.5%), the short-termist (20.9%), the indifferent (27.4%), the consumerist (14.1%) and the eco-responsible (6.2%). If an appropriate combination of measures is implemented, the household food waste issue could be addressed among all population segments and a slow but evolving behaviour change would be expected. A comprehensive action plan was developed, which comprises several generic and segment-specific measures and requires close collaboration between the authorities and further stakeholders, which are the retailer, the industry, the civil society, non-governmental organisations (NGOs) and the cultural partners. The success of the program lies in this collaboration, which offers a broad range of intervention possibilities and communication means, while enhancing the visibility of the campaign. The specificities of the Swiss context—a population known for its tenacious wasteful habits and a particularly low share of the budget allocated to food—emphasise the need for coordinated and strong action.

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## 1. Introduction

Overall, one third of the worldwide food production is lost or wasted somewhere on the way from field to fork (FAO, 2011). In the EU, the wastage represents about 20% of the community (Stenmarck et al., 2016). On the other hand, the food supply chain has been identified as the number one contributor to environmental depletion and accounts for 20–30% of the overall environmental impact caused by economic activities in Europe (Tukker and Jansen, 2006) and for 31% in Switzerland (Jungbluth et al., 2011). These figures illustrate the magnitude of the problem from an environmental point of view, the social and economic aspects being equally concerning. The shares of responsibility attributed to the agriculture and to the later supply chain stages vary across the literature, but the end consumer is consistently pointed out as a major contributor to the problem (FAO, 2011; HLPE, 2014; Priefer et al., 2016;

Stenmarck et al., 2016). This is especially true in the most industrialised countries, where end consumers waste up to ten times more food per capita than in developing countries (FAO, 2011). A recent study states that, in the EU, 53% of the food waste occurs at the consumer stage (Stenmarck et al., 2016); however, reliable data sources are generally scarce (Bräutigam et al., 2014), and studies' figures vary widely. The lack of a common definition of food waste combined with the complexity of the data gathering are the main reasons for this shortfall. Clearly, more research is needed to understand who wastes which amount and why.

### 1.1. Food waste within households

Before the launch of a large national campaign against food waste, UK consumers threw away one third of all food they bought, of which 61% was avoidable, 20% possible avoidable and only 19% unavoidable food waste (WRAP, 2008a); in the EU, 60% of the food wasted at the consumer stage is considered edible (Stenmarck et al., 2016). In 2012, UK consumers wasted the equivalent of 470 £ (1 £ = 1.23 € in December 2012 (X-Rates, 2017)) of edible food within their household, which represented approximately 14% of their

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food and drink shopping budget (WRAP, 2013a). Recent studies conducted in Denmark and Norway (Edjabou et al., 2016; Hanssen et al., 2016), the two European countries with the highest purchasing power in Europe after Switzerland (Eurostat, 2016), reported an average of 103 kg (DK) and 113 kg (NO) of edible food waste per year per household, respectively. Our own calculations allowed us to estimate that this wastage represents approximately 527 € or 11% of the household food and non-alcoholic beverages budget in Denmark and 638 € or 9% of the budget in Norway in 2015 (Eurostat, 2016, 2015a; Statistics Norway, 2016; Stenmarck et al., 2016). For comparison, it should be noted that households are slightly larger in the UK, with an average of 2.3 inhabitants compared to Norway with 2.2 and Denmark with 2.0.

### 1.2. Main causes of food waste in households

Food waste drivers can be divided into two main categories according to Secondi et al.'s (2015) proposed classification: contextual and individual variables. The first category encompasses political, socio-economic and cultural factors as well as the technological and industrial context. The concurrence of a constantly decreasing share of the food budget allocated to food combined with its apparent abundance affects the value consumers attribute to food, renders food waste affordable (Aschemann-Witzel et al., 2015; Canali et al., 2014; Eurostat, 2015b; FAO, 2011; Williams et al., 2012) and thus represents probably the most prominent contextual factors leading to household food waste in industrialised countries. Ubiquitous oversized packaging and bulk discounts (Koivupuro et al., 2012; Mallinson et al., 2016; Porpino et al., 2015; Williams et al., 2012), numerous data labelling systems (Abeliotis et al., 2014; Monier et al., 2010; Williams et al., 2012) and dietary guidance promoting fruit and vegetable consumption (Canali et al., 2014; Evans, 2011; WRAP, 2007a) are further significant external factors.

Demographic features, values, attitudes and concerns account for the individual variables. The diminishing time allocated to food supply, preparation and storage results in a lack of knowledge (Canali et al., 2014; Farr-Wharton et al., 2014; Koivupuro et al., 2012; Monier et al., 2010; WRAP, 2013b) and neglecting practices (Aschemann-Witzel et al., 2015; Fonseca, 2014; Watson and Meah, 2012); which together with busy and unpredictable lifestyles (Aschemann-Witzel et al., 2015; Fonseca, 2014; Ganglbauer et al., 2013; Kranert et al., 2012; Mallinson et al., 2016; Watson and Meah, 2012) are the major individual linked drivers. The tendency of excessive purchasing, cooking and serving, sometimes called the “good provider identity”, combined with fussy eating is another context favouring food waste generation (Aschemann-Witzel et al., 2015; Evans, 2012, 2011; Graham-Rowe et al., 2014; Koivupuro et al., 2012; Wansink et al., 2000; WRAP, 2014a). Finally, the lack of awareness about the financial, ecological and social consequences (Graham-Rowe et al., 2014; Kranert et al., 2012; Monier et al., 2010; Quested et al., 2013; Stefan et al., 2013) and the ignorance about the responsibility assumed by individual households also account for the low priority consumers assign to food waste reduction (Aschemann-Witzel et al., 2015; Graham-Rowe et al., 2014).

### 1.3. Addressing changes in consumers' behaviour

Raising awareness about the problem is crucial, but not sufficient to induce pro-environmental intentions and behaviour. The desirable behaviour should first meet the moral and social norms of the consumers, who also need to be convinced that they carry an important responsibility and that their personal behaviour has a direct impact (Bamberg and Möser, 2007; Guagnano et al., 1995; Liobikienė and Juknys, 2016). For the latter purpose, embodied experiences of the negative consequences of individual behaviour

have shown to be one of the most effective means to modify sustainably the behaviour of a large proportion of the population (Ahn et al., 2014). Realistic simulations e.g. through video games can be used to this end. The adoption of a desirable behaviour can be promoted by a targeted formulation of the message to influence the normative system of the consumer. The message should emphasise that adopting the desirable behaviour will allow the consumer to behave as the majority does and thus meet the social norm (de Groot et al., 2013).

Since an awareness-raising campaign is used as a pivotal element to reshape food waste-related behaviour, both the content and the communication means have to be carefully designed. Considering first the content, two best practices emerge from the literature: first, the development of an umbrella brand or slogan to maintain a certain consistency in the communication, and second, a strong focus on a few selected, concrete and effective measures that can be easily adopted by the target audience (DEFRA, 2008; Liobikienė and Juknys, 2016). Since the absence of pro-environmental sensitivity is a greater predictor of action than the presence of this sensitivity, too much emphasis on the environmental benefits resulting from the adoption of new behaviours should be avoided (Gust, 2004).

The variety of communication media is a further determinant of a campaign's success. The multiplication of the supports contributes to reaching a broader range of the population and exposes it repeatedly to the message. Leaflets, newspapers and personalised letters have been cited as preferred communication sources, while newsletters show the greatest impact on behaviour change (Mee et al., 2004). Personal recommendation and face-to-face contact are also recognised as very effective means of motivation (Bloodhart et al., 2013; DEFRA, 2008).

Besides the information supply, the adoption of new behaviours should be promoted via participatory instruments (Gust, 2004). The combination of several interventions, such as an awareness-raising campaign involving a broad range of actors, incentives and participatory instruments has proven to be more effective than the sum of the individual interventions (Stern, 2000) and will contribute to increase the visibility and the credibility of the message (DEFRA, 2008; Gust, 2004).

### 1.4. The use of segment-specific measures to promote pro-environmental behaviours

Interventions aiming to promote pro-environmental behaviours should enable and engage people belonging to the segments that show a high willingness to act, remove barriers such as the lack of information, organise community events or involve opinion leaders in communication. On the other hand, the definition and communication about new social norms, which might be reinforced by the example given by authorities and supported with financial incentives, are more likely to influence the behaviour of segments demonstrating less willingness to change. Targeted supply adaptation and regulation are the two means that are the most likely to have an impact on the less willing and less able segments (DEFRA, 2008). The effective adoption of new pro-environmental behaviours by the most motivated segments and by the authorities is a crucial step towards a broader adoption, as it will concretize the establishment of a new social norm and improve the credibility and the image of authorities (DEFRA, 2008; Gust, 2004). Spreading the information that the desirable behaviour will enhance the status, the well-being or finance of the person who adopts it is a further strategy worth exploring to influence self-centred segments (Liobikienė and Juknys, 2016); for this purpose, individual feedback on the personal contribution to the problem might be used (Sanquist et al., 2012). However, argumentation solely based on hedonic goals or gain goals might be shortcoming, espe-

cially if those benefits are of small significance. Thus, the message should include a reinforcement of normative goals, where the alignment of the specific behaviour with the social norm is highlighted (Refsgaard and Magnussen, 2009; Steg et al., 2014).

### 1.5. Common barriers to behaviour changes

Once the consumer is aware of the problem and of his responsibility, there are still barriers preventing behaviour change. First, the adoption of recommended practices, such as careful shopping planning and food stock management, requires additional time allocation to household duties; second, the strongly embedded habits that determine our food-related behaviour need to be questioned and modified (DEFRA, 2008; Hauser et al., 2011; Newton and Meyer, 2013); third, most of pro-environmental behaviours are perceived as inconvenient compared to less sustainable alternatives (Tucker and Farrelly, 2016); finally, socio-demographic factors, such as the presence of small children in the household, whose eating behaviour is relatively unpredictable, may reduce the room for improvement or even discourage any change (Gust, 2004). The provision of tips and material at strategic locations could help to overcome the former two barriers, would enhance the visibility of the campaign and thus increase the social desirability pressure. Proactive coping is one of the strategies that has proven to be effective in inducing sustainable changes in daily routines towards environmentally friendlier behaviours (Bloodhart et al., 2013); this highlights once more the necessity to use various dissemination techniques to reduce the gap between intentions and behaviours, on which many authors have reported (Liobikienė and Juknys, 2016; Newton and Meyer, 2013). The two latter barriers, convenience and socio-demographic factors, are the most difficult to tackle and are only likely to evolve together with the normative and cultural context (Parizeau et al., 2015).

### 1.6. Population segmentation as a research instrument in pro-environmental behaviours

In the view of the heterogeneity within consumers' sensitivities to environmental issues, several approaches from psychology, marketing and economy have been used to shed light on consumers' behaviours. Collier et al. (2010) summarised various behaviour theories arguing that attitude, social norms, habits and external factors are the four main components of consumer behaviour. These components vary across consumers, determine their motivation and barriers and thus influence their responsiveness to different interventions. A key strength of the segmentation is to shed light on these differences (Poortinga and Darnton, 2016) by clustering the consumers according to their reported current behaviour, perception of the problem and predisposition to adopt new behaviours (Collier et al., 2010; Newton and Meyer, 2013). These insights can then be used to determine who should be targeted, how the communication should best be designed, what the needs and barriers of each segments are, which measures are best tailored to meet these needs or overcome these barriers and finally, what the most cost-effective interventions are (Collier et al., 2010; Fürst, 2014). Segmentation has been widely used to investigate consumers' attitudes and behaviours towards pro-environmental practices and to design national campaigns promoting their adoption (DEFRA, 2008; Hine et al., 2013; Maibach et al., 2011; Poortinga and Darnton, 2016). While the superiority of segment-specific interventions over standardised mass communication (Maibach et al., 2011) has been demonstrated in other fields (e.g. Noar et al., 2007), there is still a lack of research on the added value of segment-specific interventions in the promotion of pro-environmental behaviours (Hine et al., 2014), with the notable exception of Bamberg (2013), which

demonstrated the effectiveness of targeted interventions to reduce car use, whereas standardised communication had no effect.

Previous research on food waste-related behaviour has focused on regression analyses and brought to light the first insights about the roots of the phenomenon (Koivupuro et al., 2012; Principato et al., 2015; Secondi et al., 2015; Setti et al., 2016; Visschers et al., 2016; WRAP, 2014b). Building on this knowledge, population segmentation is the logical next step towards a better understanding of consumers' behaviour. Other than a UK study that investigated the link between the self-reported food waste amount and convenience food consumption among different groups of younger consumers (Mallinson et al., 2016), segmentation was not applied to the consumer food waste research field. Thus, the purpose of this paper is to fill this gap by conducting the first segmentation study on a national population sample. This segmentation, which is based on previously identified food waste drivers and is complemented with a quantification table in which participants had to report their household food waste, allowed us to provide a comprehensive picture of the attitudes and behaviours of the Swiss consumers and to suggest targeted measures to tackle the problem effectively. To the best of our knowledge, this is the first comprehensive published segmentation study on consumers' food waste behaviour.

## 2. Methods

### 2.1. Sample and design

A survey was sent out by mail to a random sample of the German- and French-speaking population of Switzerland. The addresses were taken from the telephone directory. A cover letter including details about the study and assurance about the confidential data processing were included. A total of 717 questionnaires were sent back, representing a response rate of 19%. After deleting those missing more than 40 responses, 681 questionnaires remained for data analysis.

We asked the person responsible for each household's food supply and meal preparation to complete the questionnaire; since the traditional role model remains the dominant model in Switzerland (FSO, 2014), women are overrepresented in the sample population. Likewise, the youngest age group is not represented well, as most individuals under 20 live with their parents (FSO, 2010) and are not in charge of domestic duties. The data collection occurred in May and June 2016.

### 2.2. Questionnaire

The questionnaire comprised four different sections. The first section consisted of eight scales representing the food waste drivers. Further habits, attitude, knowledge, skills and behaviours related to food and food waste were assessed in the second section. The third section consisted of an enclosed table, which allowed us to quantify the food waste, and the fourth section was dedicated to demographic-related questions.

The first section was made up of 44 statements, to which the respondents had to indicate their degree of agreement on a six-point Likert scale (1 = do not agree at all, 6 = completely agree). These items allowed us to measure to which extent people plan their shopping, are driven by price and discount, are thrifty, have an overview of their food stocks, cook and eat leftovers, are aware of the environmental impact of food waste, are aware of the numerous consequences of food waste and want to be good providers. Statements were phrased positively and negatively, reflect both desirable and undesirable behaviours, and were listed randomly (see Table 1).

**Table 1**  
Scales and items used for cluster analysis, including internal consistency analyses.

Scales and items	Source
1. Planned shopping (Cronbach's $\alpha = 0.67$ ) I usually plan meals several days ahead I usually make a shopping list before going shopping I usually go shopping spontaneously <sup>R</sup> Once in the store, I buy many foods spontaneously according to what I feel like eating <sup>R</sup>	Stefan et al. (2013) <sup>Δ</sup> Stefan et al. (2013) <sup>Δ</sup> new Neff et al. (2015) <sup>Δ</sup>
2. Price and discount driven (Cronbach's $\alpha = 0.66$ ) I compare prices between product variants in order to get the best value food I always check prices, even on small items I get inspired by sales and buy food that was not initially planned In cases of bulk discount, I buy more food than initially planned	Brunso and Grunert (1995) Brunso and Grunert (1995) Neff et al. (2015) <sup>Δ</sup> new
3. Thrift (Cronbach's $\alpha = 0.62$ ) I always check the fridge prior to shopping trips In the store, I check the expiry date before buying food In the store, I check the fruits' ripeness before purchasing them When shopping, I ponder if I will be able to consume all the food before expiry It is important for me to know that I get quality for all my money I usually try to buy small packaging to minimise food waste When shopping, I consider which food stocks I already have at home	Stefan et al. (2013) <sup>Δ</sup> WRAP (2007b) <sup>Δ</sup> new new Brunso and Grunert (1995) new new
4. Stock overview (Cronbach's $\alpha = 0.82$ ) Every food has its proper place in the fridge I know which food I have in the fridge I know which food I have in the cupboard/cellar I know which food I have in the freezer I know which food will expire next I check the expiry date of the food I have at home I adapt my meal plan to first use the most perishable food Leftovers are placed in their proper place in the fridge	new WRAP (2007b) <sup>Δ</sup> new new new new Neff et al. (2015) <sup>Δ</sup> new
5. Usage of leftovers (Cronbach's $\alpha = 0.73$ ) I use leftovers in future meals I do not like to eat leftovers <sup>R</sup> I do not like to eat the same thing twice <sup>R</sup> I adapt meals to use leftovers I pack leftovers to preserve and reheat them ideally	Neff et al. (2015) Neff et al. (2015) <sup>Δ</sup> Aschemann-Witzel et al. (2015) <sup>†</sup> Neff et al. (2015) <sup>Δ</sup> new
6. Environmental impact (Cronbach's $\alpha = 0.74$ ) Food thrown away is natural and biodegradable and thus not an issue for the environment <sup>R</sup> Food thrown in compost or biowaste is not a problem, as it is natural and biodegradable <sup>R</sup> In Switzerland, packaging waste is a greater environmental issue than food thrown away <sup>R</sup> Leftovers fed to pets are absolutely unproblematic for the environment <sup>R</sup> Composted food is not a problem for the environment since the nutrients are recycled <sup>R</sup>	WRAP (2007b) <sup>Δ</sup> Stefan et al. (2013) <sup>Δ</sup> WRAP (2007b) <sup>Δ</sup> Porpino et al. (2015) <sup>†</sup> Neff et al. (2015) <sup>Δ</sup>
7. Awareness (Cronbach's $\alpha = 0.71$ ) In Switzerland, households are responsible for a great proportion of the food waste Food waste is a big environmental issue In Switzerland, the food waste generated by households has great financial consequences Food waste is an important social issue (e.g. hunger in the world) Foods are gifts of nature and have to be treated as such Foods are scarce over the world and should be consumed consciously	new new Stefan et al. (2013) <sup>Δ</sup> new Gjerris and Gaiani (2013) <sup>†</sup> new
8. Good provider identity (Cronbach's $\alpha = 0.52$ ) I always have fresh products available to be prepared for any situation (e.g. unexpected guests) I regularly buy many fresh products although I know that not all of them will always be eaten When I cook for my family or for guests, I cook more than is necessary It would be embarrassing to me if my guests ate all the food I had prepared for them I like to provide a large variety of foods at shared mealtimes so that everyone finds something he or she likes	Visschers et al. (2016) <sup>Δ</sup>

Notes: <sup>R</sup> Items reversed for analysis, <sup>Δ</sup> Items rephrased, <sup>†</sup> Items inspired from observations made by the cited source.

The second section consisted of various questions about the proportion of meals eaten in and out of home, the household food budget, the frequency of and time dedicated to cooking, the food supply source and shopping frequency. Social desirability, consumerist tendencies as well as further food waste-related behaviours and attitudes were also assessed. Cooking skills and knowledge about food storage and date labelling were measured with dedicated scales presented in [Appendix A](#).

The third section allowed us to measure the food waste generated within the household. The respondents had to indicate the amount of food they wasted during an average week for various food categories.

The fourth section related to demographic questions about gender, age, household composition, geographical area, education

level, nationality, income and finally home compost and garden ownership.

### 2.3. Data analyses and statistics

The internal consistency of the eight constructs (planned shopping, driven by price and discount, thrift, food stock overview, the usage of leftovers, environmental impact awareness, general awareness, good providers' attitude) was tested using Cronbach's alpha coefficient. The results were satisfactory for the first seven scales (Cronbach's  $\alpha$  0.62–0.82) and acceptable for the last scale measuring the good provider identity (Cronbach's  $\alpha$  0.52). The latter was maintained since it permitted us to measure a distinct behaviour, which has already been observed within the Swiss pop-

**Table 2**  
Mean scores on the clustering scales and contrast analysis results by clusters.

	Conservative 23.9%, n = 163	self-indulgent 7.5%, n = 51	short-termist 20.9%, n = 142	Indifferent 27.4%, n = 187	Consumerist 14.1%, n = 96	eco-responsible 6.2%, n = 42
Planned shopping***	4.68 <sup>D</sup>	2.63 <sup>D</sup>	3.51 <sup>D</sup>	4.44 <sup>D</sup>	3.25 <sup>D</sup>	<b>5.25<sup>D</sup></b>
Price and discount driven***	4.21 <sup>D</sup>	2.55 <sup>D</sup>	<b>4.44<sup>D</sup></b>	2.76 <sup>D</sup>	3.32 <sup>D</sup>	4.02 <sup>D</sup>
Thrift***	4.95 <sup>D</sup>	4.89	4.97 <sup>D</sup>	4.83 <sup>D</sup>	3.98 <sup>D</sup>	<b>5.48<sup>D</sup></b>
Stock overview***	5.20 <sup>D</sup>	4.96 <sup>D</sup>	4.80	4.77	3.51 <sup>D</sup>	<b>5.44<sup>D</sup></b>
Usage of leftovers***	5.69 <sup>D</sup>	5.48 <sup>D</sup>	5.20	5.02 <sup>D</sup>	4.60 <sup>D</sup>	<b>5.82<sup>D</sup></b>
Environmental impact***	2.23 <sup>D</sup>	2.28 <sup>D</sup>	2.83	2.97	3.13 <sup>D</sup>	<b>4.22<sup>D</sup></b>
General awareness***	5.22 <sup>D</sup>	5.29 <sup>D</sup>	5.20 <sup>D</sup>	4.84 <sup>D</sup>	4.35 <sup>D</sup>	<b>5.51<sup>D</sup></b>
Good provider identity***	3.47 <sup>D</sup>	3.54	<b>4.01<sup>D</sup></b>	2.74 <sup>D</sup>	3.36	2.67 <sup>D</sup>

Notes: \*\*\* $p < 0.001$ ; bold = the highest score for the variable; italic = the lowest score for the variable; Mean scores on a six-point Likert scale, 1 = "do not agree at all" to 6 = "agree completely"; <sup>D</sup> Indicates the distinctiveness of the cluster against all others for the selected scale.

ulation (Visschers et al., 2016). This latter scale as well as many of the items of the other scales were taken from previous studies and were rephrased, when necessary, to match Swiss wording; details about the items sources as well as the results of the validity and internal consistency analyses are summarised in Table 1.

The means of the eight scales were then computed and subjected to hierarchical cluster analysis employing Ward's method using the squared Euclidean distance. Solutions between two and eight clusters were assessed using the agglomeration schedule and computing the percentage of change in the clustering coefficients. Neglecting the two-clusters solution according to Backhaus et al. (2016), the two largest percentage increases occurred when combining four into three clusters and six into five clusters. Therefore, the four- and the six-cluster solutions were subjected to statistical analysis using general linear models (GLMs) followed by contrast analyses. The robust tests from Welch and Brown-Forsythe were used due to the unequal cluster sizes and heteroscedasticity. For both solutions, the clusters were significantly different ( $p < 0.001$ ) across all scales. The contrast analyses showed that each cluster stood out significantly ( $p < 0.05$ ) from the others across at least five of the eight scales, and again for the four and six-cluster solutions. These results indicate the presence of six distinct clusters and justified to retain this solution; detailed figures can be found in Table 2.

Knowhow about food storage and labelling was computed by summing the scores obtained across the nine related questions, while cooking skills were determined by the mean score obtained for the related scale. Knowhow about date labelling did not differ significantly across the clusters and was therefore disregarded for their characterisation.

Analyses with GLM, namely robust tests from Welch and Brown-Forsythe, were used to assess the significance for knowledge, skills as well as behaviours, attitudes and habits between the six clusters. Demographic variables were assessed according to the same procedure.

The analyses based on the self-reported food waste production were conducted on a subset of 506 cases, as 54 participants left the table blank and 125 further cases reported inconsistently. For each food category, the reported numbers of food waste portions were converted in grams and combined to obtain the sum of food waste per week. Robust tests from Welch and Brown-Forsythe were used to assess the difference between the six clusters. Consumers are known to underestimate their food waste when they have to report it (Ademilua, 2009; Williams et al., 2012; WRAP, 2008a); this tendency is even reinforced when people are asked to remember what they wasted during a certain period of time and then to report their average wastage (Jørisen et al., 2015). For this reason, the figures collected within this survey did not allow us to determine accurate absolute or mean values, but only relative ranks within different groups. All statistical analyses were realised with IBM SPSS Statistics 23.

### 3. Results

#### 3.1. Description of the clusters

The cluster analysis allowed us to identify six consumer segments with distinct attitudes towards the food waste issue: the conservative (23.9% of the sample), the self-indulgent (7.5%), the short-termist (20.9%), the indifferent (27.4%), the consumerist (14.1%) and the eco-responsible (6.2%). The mean scores for the six clusters obtained on the eight scales used for the segmentation as well as the contrast analyses results are presented in Table 2 and detailed in the following sections. The description is complemented with demographic features presented in Table 3 and includes further information related to the frequency of certain shopping, cooking and eating behaviours (Table 4), food-related knowledge and indicators (Table 5), main food supply sources (Table 6), attitude towards food waste, food valuation and individual responsibility (Table 7), tendencies towards consumerism (Table 8), social desirability (Table 9) and finally, the average weekly food waste production (Table 10).

##### 3.1.1. The conservative (23.9%)

The conservative consumers are driven by the traditional Swiss and Christian values of thrift and respect for work. They are determined to do their best to manage the household budget. They count each cent, spend the minimum needed, aim to avoid each kind of waste, including food waste, and make good use of cost-saving alternatives, such as their own production or second-hand goods.

The conservative consumers are likely to be stay-at-home women—possibly mothers—living in the countryside and who can rely on broad competencies in home economics, such as a respectable stock overview, good shopping planning capabilities, excellent knowledge in food storage and superior cooking abilities to achieve their goals. Besides the financial aspect, these consumers are aware of the food waste issue but ignore its environmental impact. Despite all alleged efforts, a conservative consumer does not report less food waste than the average consumer.

##### 3.1.2. The self-indulgent (7.5%)

The self-indulgent consumers live mostly alone or with a partner, do not live according to a higher financial means than their fellow citizens, but act as though that were the case, preferring high-end sources of supplies. The self-indulgents position themselves above others, need to be recognized as such and show a great capacity for self-deception. They neither exhibit particularly favourable propensities, such as organisational skills or cooking enjoyment, nor ecological awareness, but they are convinced that they waste less than others. This assertion, however, is contradicted by the result of the food waste quantification, portraying them as the second-most wasteful segment. The self-indulgent seg-

**Table 3**  
Demographic features by clusters.

	Conservative 23.9%	self-indulgent 7.5%	short-termist 20.9%	Indifferent 27.4%	Consumerist 14.1%	eco-responsible 6.2%	overall sample 100%
linguistic region***							
French speaking	33%	35%	42%	23%	34%	14%	31%
German speaking	67%	65%	58%	77%	66%	86%	69%
gender*							
male	19%	27%	28%	33%	33%	19%	27%
female	81%	73%	72%	67%	67%	81%	73%
average age*	57.2	58.7	56.7	59.0	53.3	<b>61.0</b>	57.4
average household size**	<b>2.83</b>	2.18	2.65	2.34	2.61	2.57	2.56
1 person	10%	39%	16%	24%	22%	21%	20%
2 persons	43%	33%	42%	47%	34%	45%	42%
3 persons	15%	8%	13%	11%	15%	10%	13%
4 persons	23%	12%	19%	12%	20%	12%	17%
5 persons	6%	6%	9%	6%	8%	5%	7%
≥6 persons	3%	2%	1%	1%	1%	7%	2%
geographic region*							
city	14%	20%	21%	28%	21%	17%	21%
agglomeration	24%	30%	28%	33%	40%	40%	31%
countryside	63%	50%	51%	39%	39%	43%	48%
education level*							
none	1%	4%	0%	2%	2%	0%	1%
primary	10%	2%	8%	4%	0%	5%	7%
apprenticeship	45%	40%	39%	35%	38%	39%	39%
secondary	10%	8%	6%	8%	12%	7%	9%
professional school	15%	20%	20%	20%	20%	27%	19%
technical college	8%	16%	13%	8%	8%	7%	10%
university	10%	10%	13%	23%	20%	15%	16%

Notes: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ ; bold = the highest score for the variable; italic = the lowest score for the variable.

**Table 4**  
Average weekly frequency of some shopping, cooking and eating behaviours by clusters.

	conservative	self-indulgent	short-termist	indifferent	consumerist	eco-responsible	Overall sample
meals eaten at home/person***	16.78	15.67	16.99	16.41	14.61	<b>17.21</b>	16.36
meals eaten out/person**	2.62	2.97	3.05	2.26	<b>3.86</b>	1.95	2.78
lunches cooked at home***	<b>5.22</b>	4.08	4.94	4.65	3.86	5.21	4.73
meals cooked at home**	<b>10.71</b>	9.50	10.50	9.86	9.03	10.63	10.10
top-up shopping trips*	1.97	2.69	<b>2.70</b>	2.37	2.49	2.30	2.38

Notes: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ ; bold = the highest score for the variable; italic = the lowest score for the variable.

**Table 5**  
Food-related knowhow and indicators.

	conservative	self-indulgent	short-termist	indifferent	consumerist	eco-responsible	overall sample
Food budget per week/person in CHF**	77.10	<b>98.51</b>	82.87	95.79	80.27	77.71	85.50
Ratio of meals out/at home**	0.19	0.25	0.22	0.17	<b>0.30</b>	0.12	0.21
Time spent cooking/day (in min.) *	<b>72.47</b>	53.40	66.47	62.43	55.19	59.72	63.80
Knowledge about food storage <sup>1</sup> **	<b>13.23</b>	12.71	12.32	12.59	12.23	12.83	12.66
Cooking skills <sup>2</sup> ***	<b>5.47</b>	5.16	5.21	5.17	4.94	5.26	5.22
Garden ownership***	<b>50%</b>	20%	39%	29%	32%	48%	37%
Compost ownership**	63%	51%	47%	47%	42%	<b>64%</b>	51%

Notes: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ ; bold = the highest score for the variable; italic = the lowest score for the variable; <sup>1</sup> Sum of score across nine questions; 0 (incorrect), 1 (don't know) and 2 (correct), items are listed in Appendix A; <sup>2</sup> Mean scores on a six-point Likert scale, 1 = "do not agree at all" to 6 = "agree completely"; items are listed in Appendix A.

**Table 6**  
Food supply sources by clusters.

	conservative	self-indulgent	short-termist	indifferent	consumerist	eco-responsible	overall sample
large supermarkets	3.39	3.06	3.35	3.42	3.40	3.50	3.37
discounters***	1.55	1.11	<b>1.79</b>	1.02	1.39	1.24	1.38
premium supermarkets***	0.46	<b>0.96</b>	0.58	0.78	0.82	0.51	0.67
exotic grocery stores*	0.41	0.62	0.39	0.65	0.51	<b>0.68</b>	0.52
convenience stores**	0.57	0.64	0.83	0.60	<b>0.85</b>	0.51	0.67
small traditional supermarkets	1.52	1.29	1.29	1.16	1.23	1.29	1.30
bakery, butchery, dairy**	2.11	<b>2.57</b>	2.21	2.29	1.88	2.25	2.19
market/direct from producer	1.56	1.96	1.63	1.72	1.47	1.73	1.65
own production/hunt/fishery/garden***	<b>1.73</b>	0.83	1.30	0.98	0.83	1.59	1.23

Notes: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ ; bold = the highest score for the variable; italic = the lowest score for the variable, Assessment conducted on a 5-point Likert scale: 0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = (almost) always.

**Table 7**  
Assessment of attitudes towards food waste, food valuation and individual responsibility by clusters.

	conservative	self-indulgent	short-termist	indifferent	consumerist	eco-responsible	overall sample
<b>Attitude towards food waste</b>							
Modern lifestyle triggers some food waste***	2.82	3.10	<b>3.45</b>	2.69	3.41	1.67	2.95
I sometimes have to discard leftovers because I've eaten out***	1.62	2.10	2.15	1.79	<b>2.57</b>	1.36	1.93
I forget about leftovers until they are too old to eat <sup>1Δ</sup> ***	1.43	1.67	2.12	1.66	<b>2.49</b>	1.29	1.80
<b>Food valuation</b>							
Today's food production methods are efficient and require few natural resources**	3.29	2.94	<b>3.51</b>	3.21	2.81	2.85	3.19
Today's food prices are too high**	3.69	3.54	<b>4.11</b>	3.32	3.91	3.38	3.68
<b>Individual responsibility</b>							
When I throw food away, I feel guilty <sup>2</sup> ***	5.65	5.59	5.39	5.17	4.53	<b>5.66</b>	5.30
Whenever possible, I try to avoid discarding food***	5.20	5.20	5.32	4.55	4.33	<b>5.65</b>	4.95
I follow some principles to avoid discarding food***	2.78	2.96	3.59	2.80	<b>3.83</b>	2.00	3.07
I throw less food away than the average Swiss**	2.87	3.41	3.36	3.14	<b>3.45</b>	2.36	3.14
I know how much food is thrown away in my household <sup>2Δ</sup> ***	5.65	5.47	5.02	5.34	4.51	<b>5.83</b>	5.27
I am aware of how much money I pay for the food thrown away in my household <sup>2Δ</sup> ***	5.65	5.38	5.34	5.05	4.24	<b>5.78</b>	5.21

Notes: \*\* $p < 0.01$ , \*\*\* $p < 0.001$ ; bold = the highest score for the variable; italic = the smallest score for the variable; Mean scores on a six-point Likert scale, 1 = "do not agree at all" to 6 = "agree completely"; <sup>1</sup> Inspired by Neff et al. (2015), <sup>2</sup> Stefan et al. (2013); <sup>Δ</sup> Items rephrased.

**Table 8**  
Assessment of consumerist tendencies by clusters.

	conservative	self-indulgent	short-termist	indifferent	consumerist	eco-responsible	overall sample
<b>Purchasing consumer goods such as clothes, furniture and electronics...</b>							
I consider the resources needed for the production and delivery of the good***	3.74	3.63	<b>3.86</b>	3.70	2.75	3.85	3.61
I select the good that will last the longest***	4.75	4.38	4.46	4.33	3.61	<b>4.76</b>	4.38
Before buying a new item, I take into consideration the reparation of the one I presently own***	5.12	4.67	4.72	4.66	3.94	<b>5.22</b>	4.71
I consider second-hand goods**	<b>3.26</b>	2.34	3.21	2.87	2.91	2.86	3.00

Notes: \*\* $p < 0.01$ , \*\*\* $p < 0.001$ ; bold = the highest score for the variable; italic = the smallest score for the variable; Mean scores on a six-point Likert scale, 1 = "do not agree at all" to 6 = "agree completely".

**Table 9**  
Assessment of social desirability by clusters.

	conservative	self-indulgent	short-termist	indifferent	consumerist	eco-responsible	overall sample
<b>Self-deception<sup>1</sup></b>							
My first impression about people is generally the right one*	4.67	5.00	<b>4.73</b>	4.56	4.45	4.78	4.66
I always know why I like something*	4.63	4.73	<b>4.63</b>	4.62	4.10	4.63	4.56
<b>Deception of others<sup>1</sup></b>							
I am always honest with others**	5.05	5.08	5.07	4.73	4.44	<b>5.00</b>	4.88
I have received too much change from a salesperson without telling him or her**	1.81	1.63	2.01	1.65	2.20	<b>1.54</b>	1.83

Notes: \* $p < 0.05$ , \*\* $p < 0.01$ ; bold = the highest score for the variable; italic = the smallest score for the variable; Mean scores on a six-point Likert scale, 1 = "do not agree at all" to 6 = "agree completely"; <sup>1</sup> Winkler et al. (2006).

**Table 10**  
Clusters ranking according to the mass of food waste generated within their households.

	Conservative	self-indulgent	short-termist	indifferent	consumerist	eco-responsible
FW per household***	4	5	2	3	1	6
FW per person***	4	2	5	3	1	6

Notes: 1 = the highest amount of food waste, 6 = the smallest amount of food waste, \*\*\* $p < .001$ .

ment shows the highest proportion of people who did not complete compulsory school.

### 3.1.3. The short-termist (20.9%)

The short-term oriented consumers live in two- or more-person households, lack organisational skills and perhaps time for household duties and put quantity over quality. Indeed, they are a bit thrifty, but above all price driven; they are the most likely to go shopping at discounters but also at convenience stores, where they

probably carry out their frequent top-up shopping trips. The short-termists follow desirable mainstream social norms and thus want to be good providers for their family and guests; this tendency combined with rather low planning capabilities translates to an oversupply of food, which then has to be discarded. Being followers rather than leaders, short-termists do not really consider alternative patterns. They assign little value to food and ignore the environmental impact that food production and thus food waste may have. French speakers are overrepresented in this group.

### 3.1.4. The indifferent (27.4%)

The indifferent consumers comprise a higher proportion of German speakers, urban dwellers and men, are likely to live in two-person households, to dispose of substantial financial resources and to have a rather high food budget. These consumers assign little priority to domestic duties, which is reflected in their lack of stock overview, poor usage of leftovers, little effort to find the best price or the best value or even to minimize food waste. Despite their high level of education, indifferent consumers are not particularly aware of the food waste issue. These consumers are also characterised by their absence of the need to be a good provider or to meet social norms.

### 3.1.5. The consumerist (14.1%)

The consumerists, as their name implies, neither plan nor reconsider their purchases and consumption. They make the greatest use of convenience shopping, have poor cooking skills, lack knowledge in food storage and consequently spend the least amount of time cooking. Instead, they eat out and let their food stock and leftovers turn bad, which is, in their eyes, the simple consequence of a modern lifestyle. This attitude logically results in the highest food waste generation among all segments. More generally, the consumerists are disconnected to food production, unaware of the food waste issue and are not concerned about the topic. This ignorance is well illustrated by the presumption consumerists make, when they claim to be less wasteful than the average Swiss. Consumerists comprise the youngest group and exhibit a slightly greater proportion of men; they are relatively high educated and show no need to follow social norms.

### 3.1.6. The eco-responsible (6.2%)

The eco-responsible consumers are not only the most aware about the food waste issue, but they are the only ones who perceive the environmental dimension of the problem. The eco-responsible show a great sense of individual responsibility and aim to make the best use of all kinds of resources to minimize their impact. They have a very good stock overview, conscientiously plan their purchases and reuse leftovers; they are very thrifty, rarely eat out and waste significantly less food than all other segments. Furthermore, eco-responsible consumers have close ties with food production; they frequently own a garden or buy directly from the producer, and they are the most likely to have a compost. Women, German speakers and older people are overrepresented in this consumer group; they also have good cooking skills and good knowledge in food storage.

## 4. Discussion and conclusion

### 4.1. Implications for food waste reduction programs

Previous studies about food waste behaviour highlighted how difficult it is to motivate people to reconsider their daily practices, which are strongly embedded in routine (Evans, 2012) and permanently subjected to competition with a range of more important things to do or care about (Watson and Meah, 2012). Similarly, tenacious habits are supposed to be responsible for the discrepancy consumers show between their sensitivity to ethical and environmental aspects of food and their observed behaviours (Hauser et al., 2011). The results from the present study show that the six disclosed segments differ noticeably in their self-reported food waste attitudes and behaviours as well as in their predisposition to modify their behaviours. This finding along with the previous considerations justify the development of a strong and segment-specific action plan to tackle the household food waste issue.

As awareness campaign designers, policy makers, initiatives coordinators and innovation funders, the authorities play a piv-

otal role in the success of the program. The conception of a broad awareness campaign is one of the core tasks in the program and should be led by the authorities. This campaign should focus on the three segments that show both potential for improvement and interest in hedonic and gain goals (Liobikienė and Juknys, 2016), namely the conservative, self-indulgent and short-termist consumers. Beside the umbrella brand, under which the campaign should become familiar (Gust, 2004), the program leaders should elaborate upon a small number of messages that spur the population to adopt impactful but effortless behaviour changes (DEFRA, 2008; Liobikienė and Juknys, 2016). The messages should call to the normative system of the consumers, inviting them to adopt well-regarded and beneficial behaviours (Liobikienė and Juknys, 2016) and to communicate about their personal contribution (de Groot et al., 2013). As an example, the food savings realised thanks to the systematic use of leftovers could be quantified with an online calculator, expressed both in financial gain and developing countries' meal equivalents and posted on social media. Politicians and celebrities could be used as leading figures, which show what 'the right thing to do' is (Graham-Rowe et al., 2014), by sharing about their own contribution and inviting citizens to join the movement. To enhance its credibility and contribute to shaping the new social norm, the authorities should also introduce visible changes in their sphere of influence (DEFRA, 2008; Gust, 2004), for instance, systematically reducing the first serving size and encouraging guests to come back for a second serving in all government-run canteens. The introduction of the food waste topic in compulsory education courses, e.g. in home economics courses (Jörissen et al., 2015; Stancu et al., 2016) is one of the single measures that reaches the whole population, including the less concerned indifferents and consumerists who, similarly to their Britannic counterparts—the casual consumers and the kitchen evaders (Buckley et al., 2007; Mallinson et al., 2016)—are particularly difficult to sensitise. Since the reduction of the household budget has shown to lead people to adopt most or all the recommended food-saving behaviours (Abeliotis et al., 2014), the use of more interventionist means, such as the reduction of agricultural subsidies and the allocation of all production costs on the products, would lead to an increase in the value attributed to the food and encourage thriftier behaviours. However, it should be noted that any changes going in that direction require the prior revision of international subsidies and trade regulations. Among further actors, the retail is, thanks to its power to influence consumption, an inescapable collaboration partner for the authorities. Through the substitution of bulk discounts by the promotion of local and sustainable products or ingredient packs including multiple recipe ideas, both the conservatives' and the short-termists' needs are addressed and their respective food waste might be reduced. Combined shopping and meals list templates, portion size information on the shelves, small cards with recipes based on leftovers or further advice to minimize food waste (Quested et al., 2013; Schneider, 2009; Stancu et al., 2016) are simple and efficient instruments that could be implemented by retailers and would support short-termists and consumerists, who lack time and systems for household duties and might also interest thrift consumers, such as the conservatives. The second strength of the retail is to acquire consumers' contact details. This enables consumers belonging to all segments to be reached and to communicate major changes or organisational advices through some of the most efficient and appreciated channels, which are newsletters and personal letters (Mee et al., 2004). An example of a major and urgent needed change would be the introduction of a new cross-sectorial unified date labelling system (Aschemann-Witzel et al., 2015; Monier et al., 2010). Besides the information given by the retail at shelves, the food industry could also help consumers to purchase adapted food quantities, by generalising portion size information on the front of packages. Other industries have a role

**Table 11**  
Multilateral action plan to reduce household food waste.

Stake-holders	Measures	Specific action on target segments					
		conservative	self-indulgent	short-termist	indifferent	consumerist	eco-responsible
State	Awareness campaign - create an umbrella brand - select core topics - develop core messages	Emphasis on financial losses and savings	Emphasis on status-enhancing actions	Emphasis on status-enhancing actions			
State	Introduce topics in home economics courses				Create early awareness	Create early awareness	
State	Develop new social norms acting as a pioneer in FW reduction (not only in households)		Communicate about the contributions of political leaders	Communicate about FW management in state canteens			
Retail	Design new discount forms instead of quantity discounts	Promote local and sustainable products		Promote ingredients packaged with various recipes			
Retail	Communicate about product-linked tips and tricks - on site with leaflets - to fidelity card owners via personal letters and newsletters	Provide recipes made from leftovers Organisational tips		Provide shopping and meal list templates and onsite portion size advice		Provide onsite portion size advice	
Retail	Harmonise data definition and labelling and communicate via personal letters	Introduce a new data-labelling system	Introduce a new data-labelling system	Introduce a new data-labelling system	Introduce a new data-labelling system	Introduce a new data-labelling system	Introduce a new data-labelling system
Industry	Harmonize and generalise front pack communication about portion size			Help to purchase the proper quantities		Help to purchase the proper quantities	
Industry	Focus research on furniture/app that assists in house duties				Promote innovation with time gain arguments	Promote innovation with fun-related arguments	
Civil Society	Hold workshops within associations	Become involved in workshop organisation and endorse a leadership role		Inform using personal contacts and coping			Become involved in workshop organisation and endorse a leadership role
Civil society	Manage food stock in common under the lead of pro-environmental associations		Encourage the sharing of excessive food stock				Get a leadership role
Civil society	Organise events on farms	Become involved in organisations or enhance knowhow	Enhance knowhow about food production	Enhance knowhow about food production	Enhance knowhow about food production	Enhance knowhow about food production	Enhance knowhow about food production
NGOs or cultural partners	Design an interactive and mobile exhibition: - simulation of negative consequences - personal FW calculator - sensory assessment of food - quiz about food preservation	Enhance knowhow, awareness and responsibility endorsement	Enhance knowhow, awareness and responsibility endorsement	Enhance knowhow, awareness and responsibility endorsement			Become involved in organisations as NGO members or enhance knowhow, awareness and responsibility endorsement

to play as well, especially in the development of connected kitchen equipment or apps (Ganglbauer et al., 2013; Langley et al., 2010; WRAP, 2014c), which, thanks to both their fun and practical aspects, might be adopted by consumers who are usually less concerned with household duties, but who like high-tech gadgets and can afford them, such as the consumerists and the indifferents. Associations should become involved in the program, through the call for food-saving projects such as common fridges, where surplus food can be shared with the neighbourhood; workshops, based on the example of the 'Love food Champions' conducted by WRAP and the Women's Institute in the UK (WRAP, 2008b) should also be encouraged. Such workshops allow the topic to be introduced in a more familiar framework and so to reap the benefits of face-to-face communication (Aschemann-Witzel et al., 2015; Quested et al., 2013; Sharp et al., 2010) using validated approaches, such as proactive coping (Bloodhart et al., 2013) or the 'cascade training approach', where specialists teach volunteers, who then become the leaders of groups within which the knowledge exchange occurs (Quested et al., 2013). In such projects, different consumer segments assume different roles, depending on their social connectiveness and concerns. So, it is common to find eco-responsible, conservative and short-termist consumers in a women's association, the two former endorsing leadership roles and the latter attending the workshop. Eco-responsible consumers are the most likely to be members of pro-environmental associations, which are susceptible to install common fridges for the sharing of food surplus; self-indulgents might become active food surplus suppliers, provided that their contribution is visible and positively valued. Others projects should aim to reconnect consumers with food production and enhance the value they attribute to it, e.g. through the organisation of events on farms. Depending on their design, the events might target either families, gourmets or a more technology oriented public and thus reach various segments. Finally, NGOs and cultural partners are further actors that could be mandated to organise an interactive mobile exhibition supporting the awareness campaign. Such exhibition should target a large public and should introduce various topics in a playful way. Virtual experiences with the negative consequence of food waste (Ahn et al., 2014), an introduction to the personal food waste calculator tool, sensory assessment training and a quiz about food preservation knowledge (Aschemann-Witzel et al., 2015; Monier et al., 2010) are a few activities worth including in this exhibition. A summary of the above presented action plan is presented in Table 11.

#### 4.2. Generalisation of the findings

The share of the two surveyed linguistic regions and the education level of the sample represent very well the diversity observed in the Swiss population. The household size and income distribution are also well reflected, except for single households and the highest income class, which are slightly underrepresented. Randomising the respondents within each surveyed household would include those who do not have a direct impact on the main drivers and thus complicate the interpretation of the results (Zepeda and Nie, 2012). This motivated our choice to ask those responsible for the household duties to complete the questionnaire, resulting in a female- and elderly-biased sample. Finally, foreigners and urban dwellers are two further groups that are underrepresented in the sample. Furthermore, questionnaire-based studies require the active participation of the consumer and de facto exclude people not interested in the subject (Jörisen et al., 2015) and those not ready to take the time or to offer a view of their private practices (Williams et al., 2012), thus affecting the sample's representativeness. These limitations and discrepancies should be considered, and special attention should be accorded to the segments including underrepresented groups, such as the indifferents. Taking this into

account, we still believe that our segmentation reflects the different sensitivities, current behaviours and predisposition to change that can be found in the Swiss population, but perhaps not in the right proportions. The results and conclusions are only validated for Switzerland. A comparison with a similar UK study (Mallinson et al., 2016) has highlighted some common underlying behaviours and tendencies, which results in partial segment overlap, especially among the less concerned consumers. However, further studies realised in countries with similar contextual variables are needed to assess whether the four other disclosed segments are represented in other countries or if they are specific to Switzerland. Studies realised in countries with similar mindsets, such as in the German-speaking one, would be of particular interest.

#### 4.3. Limitations and further studies

Although the underreporting phenomenon and its causes have been brought to light (Ademilua, 2009; Jörisen et al., 2015; Williams et al., 2012; WRAP, 2008a), neither its extent nor its variance among different population segments have raised much attention within the scientific community. According to the few studies that attempted to quantify it (Høj, 2011; Watanabe, 2009; WRAP, 2013c), the extent of underreporting is estimated to be of 40% or more. The observed difference in social desirability sensitivity among the disclosed segments might be an indicator of the variance of underreporting among them. In a study comparing recycling attitudes, self-reported and observed behaviours (Huffman et al., 2014), the authors identified a strong effect of social desirability on self-reported recycling in the segment showing a weak recycling attitude, but no effect on the observed behaviour. This finding would support the hypothesis that segments differ in the extent to which they misreport pro-environmental behaviours; however, a further study about electricity conservation (Gamberini et al., 2014) highlighted that the impact of social desirability varies among different electricity-saving behaviours and concluded that no cross-behavioural consistency can be expected in pro-environmental attitudes and behaviours. Thus, more research is needed on the underreporting phenomenon in food waste-related surveys to determine whether the comparison between self-reported amounts among segments is appropriate. Since in the present study, reported food waste amounts were not used to identify the segments, but only to describe them, the issue of underreporting does not affect the segmentation results whatsoever.

#### 4.4. Conclusion

Food becomes waste as a consequence of a series of time-separated events and decisions; thus, the process happens mostly unconsciously and leads to a generalised underestimation of individuals' personal contribution. A successful paradigm shift should therefore start with the implementation of measures that motivate people to reconsider their strong embedded daily practices (Evans, 2012). If the right combination of measures is implemented, the household food waste issue could be addressed among all population segments and a slow but evolutive behaviour change might be expected. To this end, the first step is to mobilize and enable the most willing consumers, namely the conservative and eco-responsible consumers, to shape new social norms. Then, the typical followers, the short-termists and self-indulgents, should be encouraged to follow the movement and to adopt new practices, thanks to a well-designed awareness-raising campaign and through the provision of supporting tips and material by different means and actors. Finally, modifying the behaviour of the most reluctant consumers, here the indifferents and consumerists, is only likely to occur over the long term, in response to

well-ingrained new social norms and generational and regulatory context changes.

We showed the benefit of a broad awareness campaign, but stressed the need to go beyond communication and to involve various stakeholders to achieve a substantial behaviour change. Some initiatives moving in that direction, such as a leaflet to harmonize date labelling or the development of a consumer guide to evaluate the state of food by interpreting date labelling and conducting sensory assessment (*Groupe de projet Gaspillage alimentaire*, 2015), have already been undertaken; however, the problem will need to be addressed more radically, involving further actors, using various communication techniques and addressing all segments in parallel. The proposed multi-lateral action plan provides suggestions and examples of measures for this purpose.

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## Appendix A. Items used for the assessment of food storage knowledge, date labelling knowledge and cooking skills level.

Items	Source
Knowledge about food storage <sup>1</sup>	
Leftovers from warm meals should be cooled down before they are put in the refrigerator	Visschers et al. (2016)
Raw potatoes should be stored in the refrigerator <sup>R</sup>	Visschers et al. (2016)
Raw fruits and vegetables last longer when stored in the fridge	
Once the original package is open, cold cuts should be repacked to be stored <sup>R</sup>	WRAP (2013b) <sup>†</sup>
Thawed meat can be refrozen after cooking	
Unaltered pasta bag and canned foods can be consumed safely beyond the expiry date	
Mouldy jam can be safely consumed after thorough removal of the mouldy part	
Mouldy cheese can be safely consumed after thorough removal of the mouldy part	
Sensory assessment (visual aspect and odour) allow one to assess if milk can still be consumed	
Knowledge about date labelling <sup>1</sup>	
The 'best before' date means that food products can become a health risk from this date on and should therefore no longer be consumed <sup>R,Δ</sup>	Visschers et al. (2016)
The 'use by' date indicates how long a product will retain its specific characteristics (e.g. yogurt should remain creamy) when stored properly <sup>Δ</sup>	Visschers et al. (2016)
The 'sell by' date is used by retailer as freshness indicator <sup>R</sup>	
Once open, the 'best before' date does not prevail anymore and the food has to be consumed within a few days	
Freezing food enhances its shelf life above the 'best before' date	
Cooking skills <sup>2</sup>	Brunner et al. (2010)
I can prepare a gratin from scratch	
I can prepare a soup from scratch	
I can prepare a sauce from scratch	
I can bake a cake from scratch	
I can bake bread from scratch	
Cooking gives me a lot of satisfaction	
Cooking enriches my life	
Cooking is my passion	

Notes: <sup>1</sup> Items changed into a dichotomous response format of 0 (incorrect) 1 (don't know) and 2 (correct); <sup>2</sup> Items assessed on a six-point Likert scale, 1 = "do not agree at all" to 6 = "agree completely"; <sup>R</sup> Items reversed for analysis; <sup>Δ</sup> Items rephrased; <sup>†</sup> Items inspired from observations made by the cited source.

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