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Need to Change, Want to Change, or Hard to Change? Targeting three dinner food waste profiles with regard to attitudes and personality traits

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ABSTRACT

In 2015, the United Nations' sustainable development sub-goal 12.3 called for halving food waste per capita by 2030. In Norway, dinner leftovers are the largest consumer food waste category, particularly in households with children. To reduce household food waste, we hypothesised that different strategies for different consumer profiles are necessary and aimed to document self-reported food waste in relation to consumers' attitudes and personalities. In a survey, 333 consumers with children reported their perceived dinner waste (PDW). In addition, we collected the respondents' attitudes towards food waste, as well as their environmental awareness and personality traits in order to classify them into three previously identified personality-environmental awareness segments. Our results show that *Need to Change* consumers (30%), characterized by Emotional Control and Openness to Experience, reported the highest PDW and showed reluctance to reduce food waste, making them a key target for interventions. *Want to Change* consumers (54%) reported the lowest PDW and showed high motivation to reduce food waste, but a further reduction from this segment would have less societal impact. *Hard to Change* consumers (15%), characterized by Conscientiousness, Agreeableness, and low Openness to Experiences, reported medium PDW. Engaging this segment could have a moderate impact, but they might be harder to reach. Our findings support the idea that environmental awareness and personality traits should be taken into consideration when developing strategies to reduce household food waste. Targeted intervention recommendations to reach each profile are derived.

1. Introduction

How we currently produce food, but not eat all of it is damaging the planet. Therefore, reducing food waste is highly prioritised on national and European political agendas. Sub-goal 12.3 in the United Nations' Sustainable Development Goals aims at halving the 2015 level of food waste per capita by year 2030 (United Nations General Assembly, 2015).

In the European Union (EU), nearly 59 million tonnes of food is wasted every year, which approximately corresponds to 131 kg per person (Eurostat, 2023). The European Commission claims that food waste represents 20 % of all the food produced and that 46 % of this waste is generated during the consumption stage (Sanchez Lopez, 2020). Households in particular contribute to 53 % of Europe's total food waste (Eurostat, 2023; Stenmarck, 2016). Reduction in household food waste is therefore a necessary contributor to tackling the food waste crisis (United Nation environment programme, 2022). In Norway, consumers accounted for 47.5 % of the mapped food waste in 2020, with dinner leftovers representing households' largest waste category, with 12.5 kg/inhabitant/year (Partnerne i bransjeavtalen, 2020). More specifically, meal leftovers account for 48 % of food waste in households with children, with leftover ingredients from dinner being the largest contributor (Stensgård & Hohle, 2023). In Norway, dinner is traditionally the main meal of the day when the family gathers at the dinner table, and the sole meal where warm foods (e.g., meat, fish, vegetables, pasta and/or rice) are served.

Since consumers are responsible for a large portion of food waste globally, to be able to develop efficient policies and interventions, it is crucial to study the determinants of food waste at the household level, and in particular, dinner food waste. Socio-demographic variables, encompassing factors such as age, income, as well as household composition and size, have demonstrated correlations with the generation of household food waste, but often no shared consensus (Vittuari

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et al., 2023). Regarding gender, some studies find females more likely to reduce their food waste than males (Barr, 2007; Secondi et al., 2015; Visschers et al., 2016), while others find that single women produce more food waste than single men or couples (Koivupuro et al., 2012; Silvennoinen et al., 2014). Regarding income, food is wasted across all income levels, but some studies find that high-income households produce more waste than low-income households (Stancu et al., 2016; Stefan et al., 2013; Szakos et al., 2021). While other studies find no correlation between household food waste and income (Koivupuro et al., 2012). Age also seems to affect food waste, where the youth tend to waste more than the elderly (Bretter et al., 2023; European Commission, 2014; Schanes et al., 2018; Stancu et al., 2016).

An aspect in several studies is household size. Some studies report that food waste was driven by household size and that an increase in the number of persons per household increased the likelihood of wasted food (Edjabou et al., 2016; Parizeau et al., 2015). However, single households are wasting the most on a per capita basis (Jörissen et al., 2015; Parizeau et al., 2015; Quested et al., 2013), which may be due to lifestyle differences and portion size challenges, as food packaging units and recipes are typically adapted for households of two or four persons (Jörissen et al., 2015).

Households with children living at home, are significantly more likely to throw out the leftovers compared to households with no children (Ellison & Lusk, 2018; Parizeau et al., 2015). von Massow et al. (2019), reported an average amount of 4.41 kg food waste per week in households (n = 94) with at least one child between 2 to 8 years old. Additionally, dinner leftovers represent households' largest food waste category, especially in households with children (Schuster et al., 2022).

Reasons for household food waste are reported to be limitations of time and money (Parizeau et al., 2015), and households with children were less likely to throw away higher-priced leftovers compared to households without children (Ellison & Lusk, 2018). Moreover, families with children tend to waste more than families without children because children often hold significant power over what kind of food is purchased and served. Often, children can interfere with parents' well-intentioned plans (e.g., weekly meal plans, shopping lists) by encouraging to more frequent grocery shopping, and choose snacks in between meals (Kansal et al., 2022), and parents may find it difficult to predict whether children will be home at all for dinner (Porpino et al., 2015).

Consumer behaviour leading to food waste is a complex web of potential interactions, referred to as "spaghetti soup" (Quested et al., 2013). Attitudinal factors and behaviour are particularly decisive for food waste at household level (Aschemann-Witzel et al., 2015; Aschemann-Witzel et al., 2021; Schanes et al., 2018; Stancu et al., 2016; Stancu & Lähteenmäki, 2022; Visschers et al., 2016). Many studies have been conducted to understand the reasons behind consumers' food waste behaviours combined with interventions to change these behaviours (Reynolds et al., 2019; Schanes et al., 2018).

Previous studies have focused on food-related household practices, including food waste practices, socio-demographic and psycho-social factors (Schanes et al., 2018). Recently, a multi-level framework was proposed that presents the relationship between consumer behaviour and household food waste, where consumers' food-related behaviour is affected at different levels: individual (e.g., attitudes, values, and habits), household (e.g., family), and external to the household (e.g., social norms, workplaces, and schools), and food waste behaviour emerges from the interaction between these three behavioural levels (Boulet et al., 2021). Boulet et al. (2021) calls for a change in food waste studies and encourage research on multilevel interventions rather than studies focusing on one single level to effectively reduce household food waste.

When looking at the individual levels, a previous study by Hirsh (2010), found a significant correlation between environmental concern and personality traits of Agreeableness and Openness. This author also reported a smaller relationship between environmental concern and traits of Neuroticism and Conscientiousness. Additionally, Williams et al. (2012) reported that households with a high environmental Consciousness wasted less edible food, especially prepared food, compared to those with low environmental Consciousness. On an attempt to organize the individual characteristics into a collective sphere, Coskun and Erbuğ (2014) argued that user diversity can be addressed by grouping users with similar characteristics into different user types, and that choosing the right target group for the proper intervention is crucial to motivate households to follow waste reduction strategies. Therefore, identifying key consumer profiles based on their personality and attitudes could allow to target different interventions to particular personality traits, to efficiently reach a larger part of the population, and thus achieve a larger global effect on reducing food waste.

There is a lack of scientific evidence for proposed interventions to reduce food waste among consumers, and there is a need for multiple and better-designed intervention studies (Reynolds et al., 2019). One reason for this gap in research can be the complexity of executing such studies, as household food waste is driven by various factors and types of behaviour (Schanes et al., 2018). Influencing consumer behaviour is an appropriate way to approach a reduction in household food waste. Personality traits influence food waste behaviour and might be a helpful predictor of waste management behaviours (Swami et al., 2011). Still, little has been done to adjust intervention strategies according to people's attitudes, environmental awareness, and personality to achieve a change in food waste behaviour. This paper contributes to filling this research gap, with a focus on households with children. Building upon previous work that identified personality-environmental awareness segments in the Norwegian population (Berget et al., 2024), this paper looks into how these identified *Need to Change*, *Want to Change* and *Hard to Change* segments relate to consumers' self-reported food waste from dinner and attitudes to food waste. Finally, we draw suggestions on the design of food waste reduction interventions targeted at the different consumer profiles.

2. Materials and methods

2.1. Participants

We conducted an online survey in March 2022 in the southeastern part of Viken County, Norway. The target group for the survey was households with children (0–15 years old) living at home. At age 16, pupils in Norway start at High School, where approximately 10 % have to move away from home (Lånekassen, 2023; Statistisk Sentralbyrå, 2024). Additional criteria for participation were to be responsible or partly responsible for grocery shopping in the family. Nofima AS was responsible for recruitment and data collection, and the questionnaire was delivered online through EyeQuestion software (v5.1.4, Logic8, Holland). The Norwegian Agency for Shared Services in Education and Research (Sikt) and Nofima's independent Ethical committee approved the study protocol before the data collection (Refnr. 775619). All participants signed an informed consent before participation in the study. An incentive of 100 NOK (≈ 10 €) to the local sports club or free-time association of the participant's choice was used to encourage enrolment in the survey. We received 474 responses, wherein 333 participants answered all questions and were retained for the analysis.

Consumers (N = 333) were categorised into six age groups, 18–29, 30–39, 40–49, 50–59, 60–69 and > 70 years old, with 66 % aged between 40–49 years old. There were more female (67 %) than male respondents. As per the selection criteria, all respondents belonged to households with at least one child under the age of 16 and were fully (55 %) or partly (45 %) responsible for food shopping. Ninety-five per cent of the consumers participating in the survey also reported to be fully (50 %) or partly responsible (44 %) for preparing dinner in their household (Table 1). The majority of consumers (82 %) in the study had University or College as their highest education level (n = 272), and 17 % of consumers reported otherwise (Table 1).

Table 1
Sample characterization of the participants (n = 333).

Measure/variable	Characteristic	Frequency	Percent
Gender	Male	110	33
	Female	223	67
Age range (years)	18–29	5	2
	30–39	69	21
	40–49	218	66
	50–59	39	12
	60–69	2	1
	>70	0	0
Education	Secondary School	1	<1
	High School	48	14
	University and college: 0–4 years	111	33
	University and college: > 4 years	161	48
	Other	9	3
Household Income	0–400 000 NOK	9	3
	400 001–800 000 NOK	41	12
	800 001–1 200 000 NOK	76	23
	1 200 001–1 600 000 NOK	102	61
	>1 600 000 NOK	85	26
	No answer	20	6
Responsible for food shopping	Main responsibility	182	55
	Shared responsibility	151	45
	No responsibility	0	0
Responsible for cooking dinner	Main responsibility	167	50
	Shared responsibility	148	44
	No responsibility	18	6
Number of children in the households	0–5 years	110	20
	6–11 years	206	38
	12–15 years	231	42

2.2. Measures

The study consisted of a 15–20 min long online questionnaire and was organised in different sections aimed to collect data about (a) perceived food waste, (b) attitudes towards food waste, (c) environmental awareness, and (d) personality traits, in addition to socio-demographic characteristics as presented above. The questionnaire was mainly based on previously tested questionnaires in the field of consumer research. Table 2 summarises the key information collected. Sections c) and d) in the questionnaire were dedicated to segmenting consumers while a) and b) were used to characterize the segments in food waste profiles.

2.2.1. Perceived dinner waste

The section for Perceived Dinner Waste (PDW) consisted of questions asking consumers to estimate their amount of food waste. We defined food waste as all edible foods in a household that are discarded in a waste bin, the organic waste container, composted, rinsed down the sink, or fed to animals, not separating liquids and solids, but excluded inedible parts such as bones and fruit and vegetable peels.

The question was based upon the "Estimated amount of food thrown away" in a report from WRAP (2020) and the food categories from the Food Waste Questionnaire (van Herpen et al., 2019), and adapted to our needs related to the dinner meal. The respondents estimated waste for 17 food categories (fresh vegetables and salads, non-fresh vegetables, fresh fruit, non-fresh fruit (frozen, canned, glass, and dried), potatoes and potato products, pasta, rice and grains, beans, lentils, chickpeas, meat, meat substitute, fish, bread toppings (cold cuts and spreads), bread and baked goods, dairy products, cheese, eggs, and sauce) by answering the following question:

> Think about the last time you prepared the following foods for dinner. Approximately what percentage of the amount you cooked, ended up not being eaten? (i.e., thrown in the food waste bin, rubbish bin, compost, rinsed down in the sink, given to animals, etc.).

For each food category, the answers were collected on a 0 %-100 % scale with 10 % increments. A "Not relevant" option was also offered in case the participant did not consume that particular food category.

Table 2
Questionnaire measurements.

Construct	Number of items	Scale	References
Perceived food waste for prepared dinners	17	0–100 %, not relevant	(van Herpen et al., 2019; WRAP, 2020)
Attitudes to Food Waste	4	Likert scale from 1 = disagree strongly to 5 = agree strongly	Developed for this study
Environmental awareness	7	Likert scale from 1 = disagree strongly to 5 = agree strongly	(IPSOS, 2021)
Norwegian short version of the Big Five Inventory (BFI-20-N)	20	Likert scale from 1 = disagree strongly to 7 = agree strongly	(Engvik & Clausen, 2011)

2.2.2. Attitudes to food waste

The measurement of consumer food waste attitudes was designed based on the theory of Comprehensive Action Determination Model (CADM) (Klöckner & Blöbaum, 2010). Consumers were asked to answer the following four statements with the goal to map dimensions known to affect consumer behaviour, such as personal and social norms: 1) My goal is to reduce food waste in my household, 2) I feel pressure from society to reduce food waste in my household 3) I am influenced by family and friends to reduce food waste in my household and 4) I feel responsible for reducing food waste in my household to contribute to a more sustainable future. The scores were measured on a 5-point Likert scale with higher scores corresponding to a higher agreement with the statement.

2.2.3. Environmental awareness

The measurement of consumers' environmental awareness towards food waste and recycling consisted of seven statements regarding sustainability: consciousness to food waste (CFW, three items) and attitudes to recycling (four items). Consumers' environmental awareness was compiled by Berget et al. (2024) based on the questionnaire in the sociocultural study Norwegian Monitor (IPSOS, 2021). The scores were measured on a 5-point Likert scale with higher scores corresponding to a higher agreement with the statement.

1. I serve leftovers to my guests (CFW)
2. I use clothes I have been given or inherited (Recycling)
3. I think about the environment when buying clothes (Recycling)
4. I am engaged in recycling of clothes, furniture and so on. (Recycling)
5. When I throw food, I get a bad conscience (CFW)
6. I throw food away when the 'best before' date has expired (CFW)
7. I throw food when the 'use-by date' has expired (CFW)

2.2.4. Personality traits

Personality traits were measured using the Norwegian short version of the Big Five Inventory (BFI-20-N) (Engvik & Clausen, 2011). The BFI-20-N contains 20 items designed to measure personality by five general dimensions – Extraversion, Agreeableness, Conscientiousness, Emotional Control, and Openness to Experience – where each of the five personality dimensions is measured by using four items. The scores were measured on a 7-point Likert scale with higher scores corresponding to a higher agreement with the statement.

2.3. Data analysis

Respondents were classified into three consumer profiles based on their answers for the 20 statements measuring personality characteristics (Big Five inventory, BFI-20-N) and seven statements measuring consumers awareness towards the environment. All 27 statements were combined into seven dimensions (CFW: Consciousness about Food Waste, R: attitudes to Recycling, O: Open to Experience C: Conscientiousness E: Extraversion A: Agreeableness EC: Emotional Control). To ensure that our three consumer profiles would align with the general population, and not solely apply to our limited sample of 333 consumers, we utilised pre-identified segments from a representative sample of the Norwegian population. The original segmentation into three segments was developed and validated based on a larger dataset of N = 3622 Norwegian respondents as described by Berget et al. (2024). Thus, we used the same 27 statements to classify our respondents into the pre-identified segments according to an LDA (Linear Discriminant Analysis) model developed and presented in (Berget et al., 2024) (for a projection of our respondent segments compared to the representative Norwegian sample into a Principal Component Analysis model, see Supplementary material 1).

Differences between the three consumer segments were assessed by using Kruskal-Wallis test and one-way Analysis Of Variance (ANOVA) with Tukey's post hoc test both for the Perceived Dinner Waste data from the 17 food categories as well as the average of the 17 food categories to represent a global "perceived dinner waste" percentage indicator for each consumer. The Kruskal-Wallis test and ANOVA were carried out using XLSTAT version 2023.1.3 (Lumivero, USA) and gave similar results. Only the ANOVA results will be presented here.

In order to further investigate to what extent, the different segments may be profiled by socio-demographics, perceived dinner waste and attitudes towards food waste, a Partial Least Squares Discriminant Analysis (PLS-DA) approach was used. First, a PLS-DA model was built for the three segments together, using the socio-demographic and food-waste attitudes sections of the questionnaire as the independent variable set (X) and consumer segments as dependent binary variables (Y_1, Y_2, Y_3). This model explained poorly each segment and showed poor face validity, as it highlighted bread toppings and cheese as key dinner waste items for differentiating the segments, whereas these products were very seldom reported at all in the data material. Following this issue, separate PLS-DA models were built for each of the segments. These models showed higher explained variances and good face validity, highlighting more dinner items as segment-relevant (e.g., meat substitutes) and showing no significance of specific lunch items. Only the separate models will be presented here. For all PLS-DA models, all perceived dinner waste answers were log-transformed before analysis due to high skewness in the distribution (skewness range before/after transformation: 1,3 to 6,6 / −1,9 to 1,4). Category variables (gender, age, income) were re-coded as binary variables (0/1) for each answer alternative. A first model was always run with all independent variables (i.e., 50 items), and this model was then refined in a stepwise procedure based upon variable selection. All PLS-DA models were run on standardised variables, using cross-validation with 20 random segments for model validation and performing a Jack-knife uncertainty test with 95 % confidence interval for the detection and selection of significant variables (Martens & Martens, 2000). The final models retain 26 independent variables, where 21 were significant. Calculations were performed in The Unscrambler X 11.0 (CAMO Analytics AS).

3. Results

3.1. Supervised classification into pre-identified segments

The three consumer segments were constructed upon seven different dimensions reflecting personality (Big Five) and environmental awareness Recycling (R) and Consciousness about Food Waste (CFW). The supervised classification indicated that all three pre-identified segments in the Norwegian population (Berget et al., 2024) were represented in our respondent sample. Fig. 1 highlights the positive or negative scores of each consumer segment in the present sample, for each of the dimensions.

Segment 1- Need to Change represented 30 % of the respondents in this study, against 40.7 % in the national representative dataset the original segmentation was based on (Berget et al., 2024). Our *Need to Change* consumers answered negatively to the statements regarding R and CFW (Fig. 1), with low scores for using clothes and furniture that have been inherited or bought second-hand. Further, they throw away food when either the "best before date" or "use-by date" has expired. This segment has a low response to the dimension of Emotional Control (high Neuroticism), with items such as anxiousness, nervousness, and poor handling of stress. Additionally, the low score to the dimension of Agreeableness is explained by being more critical, uncooperative, and suspicious. Furthermore, they score relatively high on Openness to Experience as they express being imaginative, artistic, curious, and independent.

Segment 2 – Want to Change represented 54 % of the respondents in this study, against 29.2 % in the national representative dataset the original segmentation was based on (Berget et al., 2024). Our *Want to Change* consumers have a high score for CFW and R, with for example a bad conscience related to food waste when they throw away food, and most of them do not systematically throw away food when the "best before date" or the "use by date" has expired. They are positive to using clothes and furniture that have been inherited or bought second-hand. Further, the dimensions driving this segment is particularly Openness to Experience, Emotional Control, and Agreeableness (Fig. 1). They score higher for Openness to Experience than *Segment 1*, and this personality trait is associated with being imaginative, artistic, curious, and original. They have a low Emotional Control (high Neuroticism), indicated by anxiousness, nervousness, and poor handling of stress. For the dimension Agreeableness, these consumers are more towards being critical, uncooperative, and suspicious.

Segment 3 – Hard to Change represented 15 % of the respondents in this study, against 30.1 % in the national representative dataset the original segmentation was based on (Berget et al., 2024). Our *Hard to Change* consumers reported getting a bad conscience when they throw away food, and they avoid throwing away food when the "best before" or "use-by date" has exceeded. On the contrary, they report low scores for Recycling and are not positive about serving leftovers to guests, using

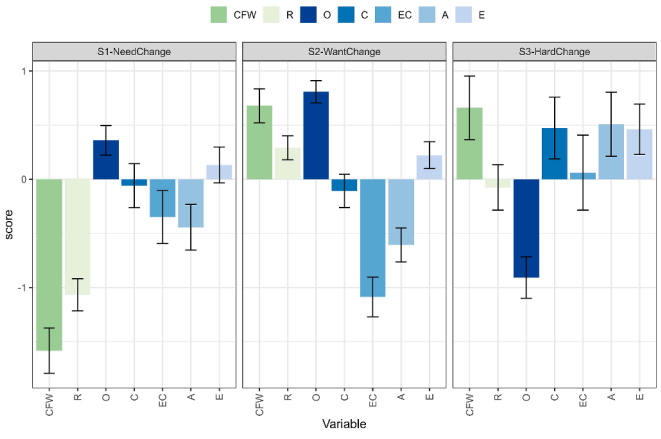

Fig. 1. Bar chart of consumers' answers on personality (Big Five) and environmental awareness for the three Segments: *S1 – Need to Change* (30 %), *S2 – Want to Change* (54 %) and *S3 – Hard to Change* (15 %) (N = 333). The bar height is the estimated marginal means (EMM), whereas the error bar is the standard error of EMM. The variables are labelled O = Open to Experience, C = Conscientiousness, EC = Emotional Control, A = Agreeableness, E = Extraversion, CFW = Consciousness about Food Waste, R = Recycling.

inherited clothes or furniture or being environmentally conscious when buying clothes. Further, consumers in this *segment* report higher scores for the dimension's Conscientiousness, Agreeableness and Extrovert personality, and low scores for Openness to Experience (Fig. 1). With high scores for Conscientiousness, this segment can be explained as planners, and they like doing a thorough job and having order in their life compared to *Segment 1* and *2*. The dimension of Agreeableness is explained by them being present, helpful, selfless, warm, and enjoying helping others. Furthermore, they score low on Openness to Experience, which indicates that these consumers scores for being imaginative, does not like change, and that they are not that interested in new things and ideas. In addition, they have an Extrovert personality, which means they are more social, outgoing, and energetic than the other segments.

3.2. Consumer segments and reported food waste

Need to Change consisted of those who had the highest average of perceived dinner waste (8.2 %), significantly different from *Want to Change* but not from *Hard to Change* (Fig. 2). They reported a significantly high amount of food waste from the food categories: fresh vegetables, potatoes and potato dishes, rice and meat compared to *Want to Change*, and of pasta and bread toppings compared to *segments 2* and *3* (Fig. 3). This segment consisted of 101 consumers (30 %) with 59 % female and 41 % male participants.

Consumers in *Want to Change* wasted the least amount of food prepared for dinner, with 5.5 per cent food waste on average across the 17 food categories (Fig. 2), and significantly lower than *Need to Change*. Nearly half of the consumers in *Want to Change* say they produce almost no dinner waste at all (n = 82). Additionally, this segment reports significantly lower perceived amounts of food waste from dinner in the categories: fresh vegetables, potato and potato products, pasta, rice, meat, and bread toppings compared to Need to Change (Fig. 3). In this segment we find the largest part of participants, with 181 consumers (54 %), where the distribution was 67 % female, and 33 % male.

The third and the smallest segment is *Hard to Change*, with 51 consumers (15 %) reporting a medium level of average perceived dinner waste (6.2 %) from dinner, not significantly different from the other two segments (Fig. 2). Consumers in this segment have significantly less food waste in the category pasta and bread toppings compared to *Need to Change* but are not significantly different from *Want to Change* in any food category (Fig. 3). The gender distribution in this segment was 80 % female and 20 % male.

3.3. Segments perceived dinner waste and food waste attitudes

The group characterization by PLS-DA revealed 21 X-variables typical for at least one of the three segments (Fig. 4). None of the variables was significantly relevant to all three segments. This indicates the presence of systematic patterns in perceived dinner waste and food waste attitudes differentiating the three segments. *S1 – Need to Change* is explained with 13 % variance, *S2 – Want to Change* with 10 % variance and *S3 –Hard to Change* with 5 % variance in one-factor models, indicating that the environmental awareness and personality traits typical of *segments 1* and *2* associate to a notable extent with food-waste attitudes and perceived dinner waste, while traits typical of *S3 – Hard to Change* are poorly related to food-waste attitudes and perceived dinner waste.

Need to Change have a low score regarding their attitudes towards food waste; they do not have a goal to reduce their food waste (p=<0.05), do not get inspiration from family and friends to reduce their food waste (p=<0.1), nor feel the responsibility to reduce their food waste (p=<0.05). Furthermore, they are significantly characterized by a high score for Sum PDW (p=<0.05) (Fig. 2), Average PDW (p=<0.05) and for seven out of the 17 food categories, in line with the results presented in Fig. 3 above. Respondents in *Want to Change* are significantly characterized by high scores in the attitudinal statements related to having a goal to reduce food waste in their household (p=<0.05), being inspired by family and friends to reduce food waste in their household (p=<0.05) and feeling responsible for reducing food waste in their household (p=<0,05). Additionally, they have a significant low score for Sum PDW (p=<0.05) and nine out of the 17 food categories (see also Fig. 3).

4. Discussion

This study aimed at characterizing consumer segments in the Norwegian population previously defined by traits of personality and environmental awareness, in terms of their perceived dinner waste and attitudes to food waste. A sample of 333 consumers representing households with children 0–15 years old participated in the study. This section discusses general findings and potential intervention strategies to reach out to the *Want to Change*, *Need to Change*, and *Hard to Change* segments.

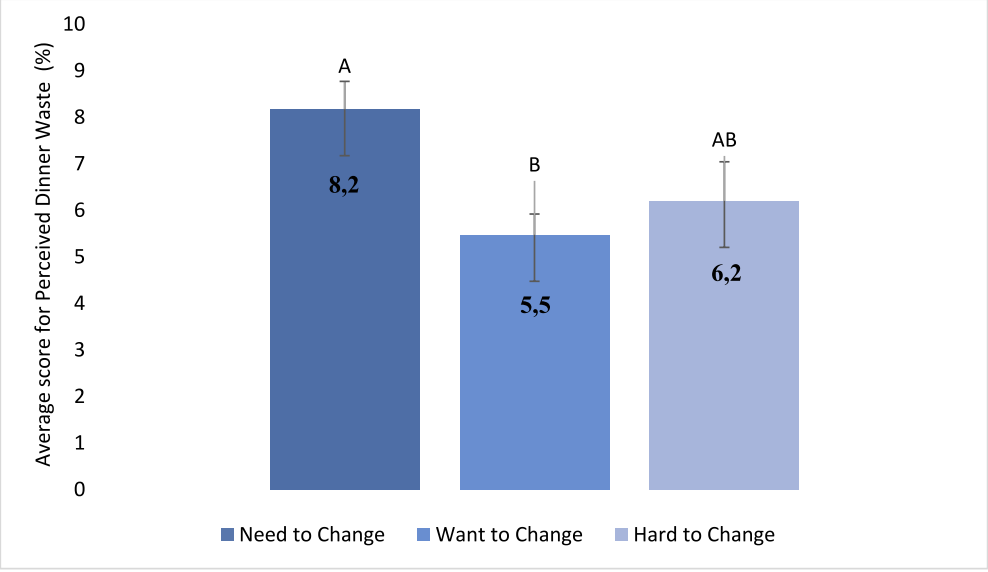

Fig. 2. Average score for Perceived Dinner Waste for S1 – Need to Change, S2 – Want to Change and S3 – Hard to Change (N = 333). Different letters indicate significantly different average scores across segments using ANOVA and Tukey's post hoc at p < 0.05.

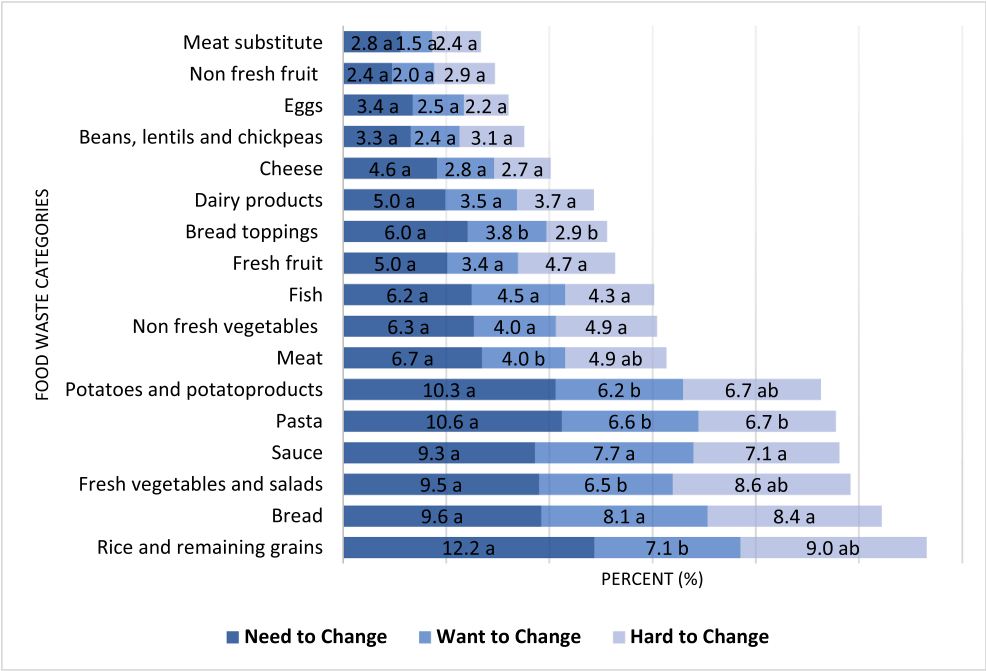

Fig. 3. Self-reported percentage of dinner waste from 17 Food Waste Categories at home for S1 – Need to Change, S2 – Want to Change, and S3 – Hard to Change (N = 333). Different letters indicate significantly different average scores across segments using ANOVA and Tukey's post hoc at $p < 0.05$.

4.1. Perceived dinner food waste and socio-demographic, awareness and attitudinal effects

Our study observed through the self-reporting of Perceived Dinner Waste (PDW) for 17 food categories, our study observed rice and remaining grains, bread, fresh vegetables and salads, pasta, sauce, and potatoes and potato products to be the food waste categories with the highest percentage of PDW. These results are in line with Stensgård et al. (2023), who investigated the self-reported food waste from all meals of the day and concluded that in Norway, bread and baked goods is the food category with the highest waste per week, followed by fresh vegetables and salads, liquid dairy products, beverages, and potatoes and potato products. A busy lifestyle for households with children makes it difficult to make plans and establish routines for shopping and storing of food products and leftovers. Numerous consumers buy larger quantities of a food product intended for a specific meal than necessary (Evans, 2011), and this might be especially problematical for storage-sensitive products such as vegetables. Further, food categories like rice, pasta and potatoes may be difficult to portion rightly, especially as caregivers are often concerned about not satiating everyone at the table and prefer preparing too much than too little (Silvennoinen et al., 2014). According to Mavrakis (2014), many consumers prepare too much food in order to store for another meal to save time later, but they often find it unappealing later and it ends up being thrown away.

We observed no significant impact of gender, age, education or income, implying that socio-demographic do not have as large an influence on personality traits and food waste. In the majority of our households the respondents where in the age group 40–49 years old (65 %), and according to Stensgård and Hohle (2023) this group shows the largest amount of food waste in Norwegian households. We therefore believe we have reached an important group of households in our study, where the potential for food waste reduction is the greatest. Most of our participants had an education at University or College level, which may be the reason why no significant differences due to education were found. Some studies have identified socio-demographics such as gender, household size and education level to correlate with consumer food waste, while other studies report the opposite indicating no consensus across study samples (Vittuari et al., 2023).

Furthermore, environmental awareness emerged in our study as an important predictor of food waste. Consumers who had a low score for Consciousness about Food Waste (CFW) had a significantly higher self-reported food waste compared to those who scored high on CFW. It thus appears that consumers transfer their environmental awareness into actual action when it comes to food waste. Similarly, in a study on 118 Danish households, Tsalis et al. (2024) report lower measures of food waste in environmentally concerned consumers. Susilo et al. (2022) found that the majority of 400 respondents in Asia, were conscious of the problem of food waste and took effective steps to address it. Among the remaining study participants, some were aware of the hazards linked to food waste but chose to disregard its significance, while a few remained entirely unaware of their own food waste practices. A solution for reducing food waste might therefore be to raise consumers' awareness through for example information campaigns (Mirosa et al., 2016).

In addition, having a goal to and feeling a responsibility for reducing food waste received a high score among consumers who reported a lower Perceived Dinner Waste. This indicates that consumers who are aware of their food waste and feel a responsibility to reduce it are more likely to act. In line with these findings, previous research revealed that people with positive attitudes about reducing their food waste showed a higher intention to reduce their food waste and reported wasting less food (Visschers et al., 2016). Consumers' lack of awareness about their food waste being part of the global food waste problem, might be a reason for the differences in attitudes and practices between segments in our study. Communication strategies that fail to effectively reach the population at large, can lead to different perceptions of personal responsibility and goal-setting behaviours. Addressing these gaps in knowledge and perception could involve for instance targeted educational campaigns to highlighting individual contributions to the global issue. Ishangulyyev et al. (2019) argue in their review that educational campaigns at a national level that influence individuals' attitudes toward reducing food waste hold significant importance.

4.2. Using Consumer segments for designing food waste interventions

The *Need to Change*, *Want to Change* and *Hard to Change* segments differed in their attitudes towards food waste, personality traits,

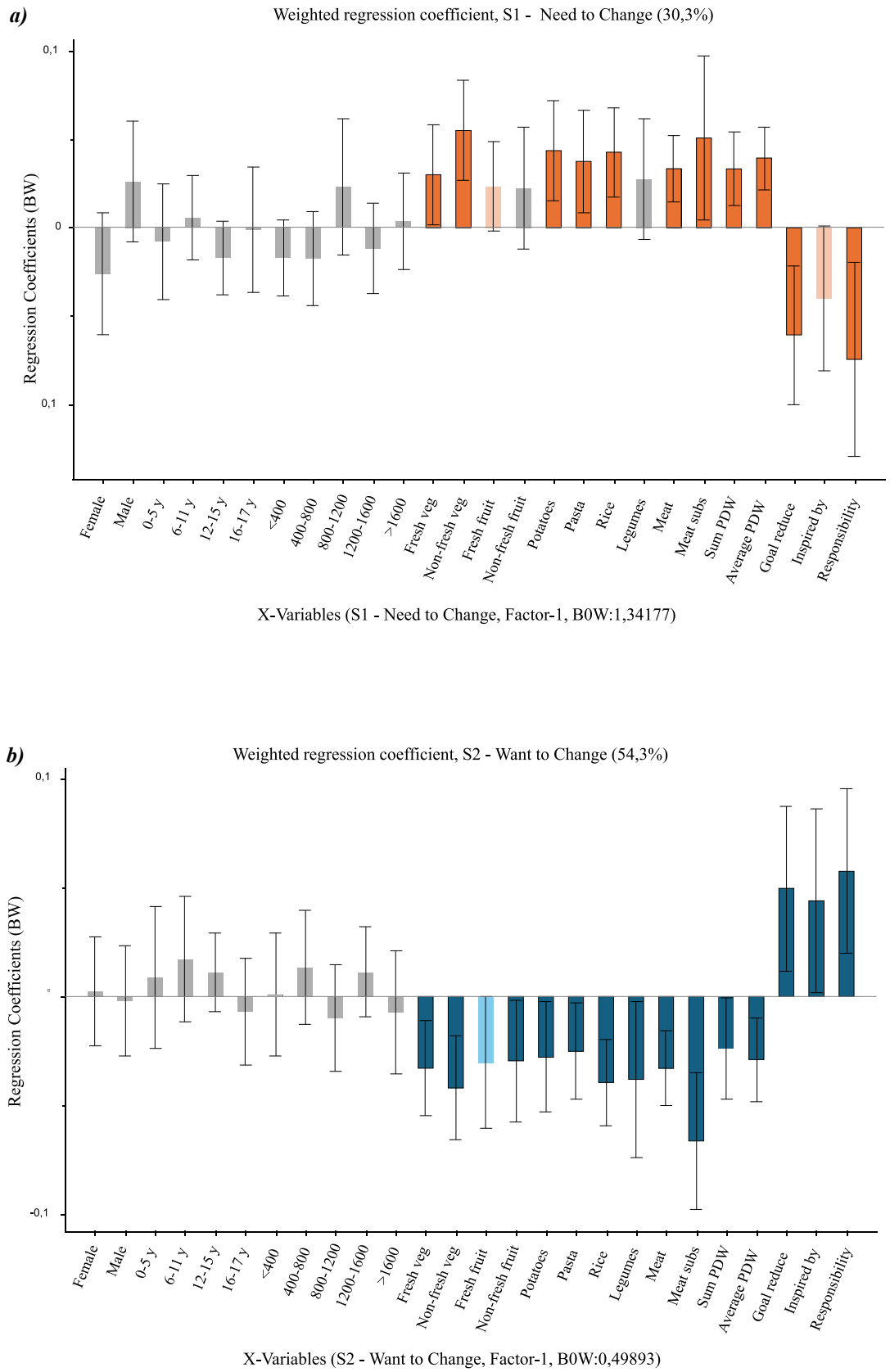

Fig. 4. Weighted regression coefficients and significant group characteristics for a) Segment 1 – Need to Change, b) Segment 2 – Want to Change from PLS-DA. Dark bar colours (dark orange, dark blue) indicate significance at 5% level, light colours (light orange, light blue) indicate significance at 10% level, and grey colour indicates non-significance. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

environmental awareness and PDW. Within the literature examining environmental consciousness, researchers increasingly agree that attitudes and behaviours serve as the key determinants for characterizing sustainable consumer groups (Balderjahn et al., 2018; Golob & Kronegger, 2019). Our results corroborate previous findings on the effects of consumer profiles (Annunziata et al., 2022; Coskun, 2021), and emphasize that individual personality traits and environmental awareness must be considered when choosing strategies to reduce consumer food waste.

4.2.1. Need to Change

Need to Change consumers (30 %) reported the highest PDW of our three segments, with starchy foods (Rice and remaining grains, Pasta, Potatoes, Bread), and Fresh vegetables and salads being the largest food waste categories. Despite their higher waste, the *Need to Change* segment does not feel a responsibility nor have a goal to reduce their household food waste. Disclaimer of responsibility is seen as a barrier to reduce household food waste, and consumers may transfer the responsibility of food waste to retailers (Nunkoo et al., 2021), claiming that the quality of the products purchased was too poor in the first place (Graham-Rowe et al., 2014), or that purchasing promotional goods (e.g., "3 for 2" offers) leads to excessive purchases (Porpino, 2016). *Need to Change* consumers also report throwing away food when the "best before" labelling has exceeded, which might indicate that they either mix the terms "best before" and "use-by date" and are therefore uncertain about food safety after the labelled date, or that they have a strong focus on sensory quality and reject any sensory deviation from the freshest version of the product. A review based on five studies conducted in Europe concluded that many consumers do not differentiate between "best before" and "use-by date" and tend to waste fully edible food (European et al., 2018).

The *Need to Change* segment are characterized with personality traits of Openness to Experience, and low Emotional Control and Agreeableness. They also reported the highest amount of perceived dinner waste. Individuals with high Openness to Experience tend to be more open-minded and amenable to new ideas and concepts (Shiner & DeYoung, 2013). Although this segment had the highest food waste in this study, the promotion of more Openness may in accordance to Hopwood et al. (2021) be a pathway to promote more sustainable behaviour. Openness and Agreeableness have both been linked to caring for others (Olver & Mooradian, 2003; Roccas et al., 2002). A lower level of Agreeableness is associated to a more selfish behaviour and a lower consideration for others (Hirsh, 2010), and this might lower consumers' personal motivation for food waste reduction towards the good of society. Annunziata et al. (2022) point out that consumers with a lower level of guilt towards their wasteful behaviour tend to waste more. It's plausible to suggest that this group of consumers might hold a perspective where they see food waste as a global concern rather than a personal responsibility (Annunziata et al., 2022; Vittuari et al., 2020). In this sense, consumers in the *Need to Change* segment might be difficult to reach, but as they discard a lot of foods, it is an important group to reach in the perspective of achieving national and EU-targets in food waste reduction.

Several interventions have been suggested and/or tested with consumers (Reynolds et al., 2019). However, which type of intervention suits different consumers is not clear. Individuals who are high on the Openness to Experience dimension are open to new things and challenges and are curious. Accordingly, the higher the Openness to Experience personality traits is, the more likely they are willing to endorse new challenges and improve themselves (Wang, 2010). A curious consumer with high willingness to change might be motivated by interventions that increase knowledge. For example, in a web-based survey investigating among others; awareness and attitudes towards food waste and intentions to reduce food waste behaviour, Annunziata et al. (2022) found a similar group ("Self-indulgent"), to our *Need to Change* segment, with a wasteful behaviour while feeling less guilty about it. These authors suggested having policymakers and practitioners implement educational campaigns or social marketing programs to raise consumer awareness and encourage the consumers to a food waste reduction (Annunziata et al., 2022). However, as far as we know targeted interventions have not been tested on specific consumers profiles with interventions adapted to their personality traits; there is therefore a need in future studies to examine this in practice. Based on the socio-cultural study Norwegian Monitor (IPSOS, 2021) we estimate this group to correspond to 40 % of the general population and therefore it is an important group to reach for policymakers. The *Need to Change* segment might benefit from being invited to visit dedicated webpages with focused info on the subjects of food waste prevention and food safety or may adopt technological solutions such as shelf-life indicators (e.g., time–temperature trackers) that indicate whether the food is safe or not to eat. Furthermore, another possible way of challenging the *Need to Change* consumers, could be by creating a competitive game where they compete with themselves or others to reduce their amount of food waste. For example, de Vette et al. (2016) report that Openness to Experience influences preference for game content.

4.2.2. Want to Change

Consumers in the *Want to Change* segment (54 %) reported the least amount of food waste among our consumer segments, with Bread, Sauce and Rice and remaining grains, being their largest food waste categories. Almost half of the consumers in this segment reported that they never throw away food at all. In contrast to the two other profiles, these consumers showed higher awareness, environmental consciousness, and responsibility towards food waste reduction, yet do not feel a direct pressure from society to reduce their food waste. Our results align with Annunziata et al. (2022) who found a similar group of consumers ("Proactive") with a low amount of reported food waste, who are aware of the food waste problem and have a significantly higher feeling of obligations to reduce their food waste. As they are already very conscious of their actions related to food waste, it is likely that consumers in the *Want to Change* segment need very specific advice to improve further. Like conducting a brainstorming exercise for the whole family to identify where their biggest food waste challenges lie, or joining a social network group for sharing tips and inspiration.

Previous studies have linked the three personality traits Agreeableness, Conscientiousness, and Openness to Experience to environmental engagement (Hirsh, 2010; Milfont & Sibley, 2012). Therefore, these traits could be expected to be salient in consumers with the lowest amount of food waste. Our *Want to Change* segment had high Openness to Experience traits, but neither Agreeableness nor Conscientiousness. A high Openness to Experience is associated with being creative, open to trying new things and tackling new challenges (Shiner & DeYoung, 2013), and these respondents are likely willing to engage in new challenges to improve themselves (Wang, 2010). Milfont and Sibley (2012) found that Openness to Experience was significantly associated with pro-environmental behaviours, thus it is likely that consumers in the *Want to Change* segment would engage in environmentally friendly consumption behaviour such as, food waste reduction.

Want to Change consumers were low on Emotional Control (strong Neuroticism) and described as more anxious, sensitive, and they presumably worry more. Neuroticism has been related to environmental concern, and people with this personality trait tend to be generally more worried about negative environmental outcomes (Hirsh, 2010). Therefore, anxious consumers might be most driven to engage in sustainable behaviour through their concern for the environment and as a result lead to their bad conscience, guilt, and responsibility to reduce their household food waste. Efforts aimed at this group could potentially help them shift from a more negative "loss frame", due to anxiety, to a more positive "gain frame" focusing on building a better future (Chen, 2019). Concerning prevention strategies, this segment might be willing to partake in food sharing, to contribute to their food waste management (Coskun, 2021). The *Want to Change* segment is a motivated group and therefore is a manageable group to reach in intervention programs with the goal to reduce household food waste. However, this might not result

in a significant reduction since *Want to Change* already stand lower in waste compared to the two other food waste profiles.

4.2.3. Hard to Change

Hard to Change consumers (15 %) report an intermediate amount of food waste between *Need to Change* and *Want to Change*, with Rice and remaining grains, Bread and Fresh vegetables and salads being the most essential food waste categories. This segment reported a concern for food waste and getting a bad conscience when they throw away food. Still, they are characterized by low general sustainable attitudes to recycling and reusing clothes or furniture.

Personality traits such as Agreeableness, Conscientiousness, and low Openness to Experience characterized the *Hard to Change* consumers. Since this segment had a high score for Conscientiousness, they can be described as planners, who like doing a thorough job and are organized and dependable. We could have expected a lower food waste in this segment than in the other two segments, since Conscientiousness has been related to green behaviour (Gordon-Wilson et al., 2022; Hirsh, 2010; Milfont & Sibley, 2012), however this segment was not significantly different from the other two. To take advantage of their personal characteristics of being planners, interventions such as preparing shopping lists, weekly meal plans and systemizing food inventory, with fridge inventory apps for example, might be effective. Several publications have found that using shopping lists was critical in preventing food waste. In addition, Di Talia et al. (2019) found that shopping at long intervals increased the tendency of food waste because of bulk buying food. Furthermore, Quested et al. (2013) report that people who planned meals on a weekly basis were more likely to keep a running shopping list compared to those who decided the meal day by day. Therefore, the impact of reaching the *Hard to Change* segment is less than the *Need to Change*, but higher than the *Want to Change* in the sense of food waste amount.

4.2.4. The need for bespoke policy implementation

In 2022, national authorities established and sought feedback from the Norwegian Food Waste Committee to address food waste reduction (Klima- og miljødepartementet & matdepartementet, 2023). The committee's report presented 34 suggestions for reducing food waste, with only two specifically targeting consumers: National food waste campaigns and nudging (Matsvinnutvalget, 2023). However, no guidelines have been established on how to implement these measures. The suggestions highlighted in this paper have significant potential to influence consumer behaviour and reduce household food waste if implemented through policy. Thus, it is important for follow-up research to test suggested interventions and their effectiveness on the different consumer profiles.

A summarisation is made in Fig. 5 for the three investigated segments – *Need to Change, Want to Change,* and *Hard to Change* – with different personalities, environmental awareness, attitudes and self-reported dinner food waste, and highlights our suggestions for recommended food waste intervention strategies. In summary: rather than a single one-size-fits-all campaign, it may be more effective to target the National food waste campaigns and nudging based on the interventions targeted to our three segments.

4.3. Limitations and future research

In this study a self-reported survey was applied to measure perceived dinner waste. One of the drawbacks of self-reported food waste from consumers is the possibility of underestimating their food waste (van der Werf et al., 2020), but on the other hand, curbside measurements are costly, and may not be suitable to measure dinner food waste specifically as was the scope of this paper. Further studies may utilise self-reporting measures that are not dependent on long-term recall. Moreover, future studies comparing self-reported direct measurement of food waste to self-reported estimates could be a way to reduce bias of results (Kasza et al., 2020; Nováková et al., 2021). However, this would increase respondent burden, especially in a several-week study, with the risk of substantial drop-out rates.

Our consumer sample differed from the national Norwegian representative sample in terms of distribution percentages of respondents across the three segments with approximately 11 % fewer *Need to*

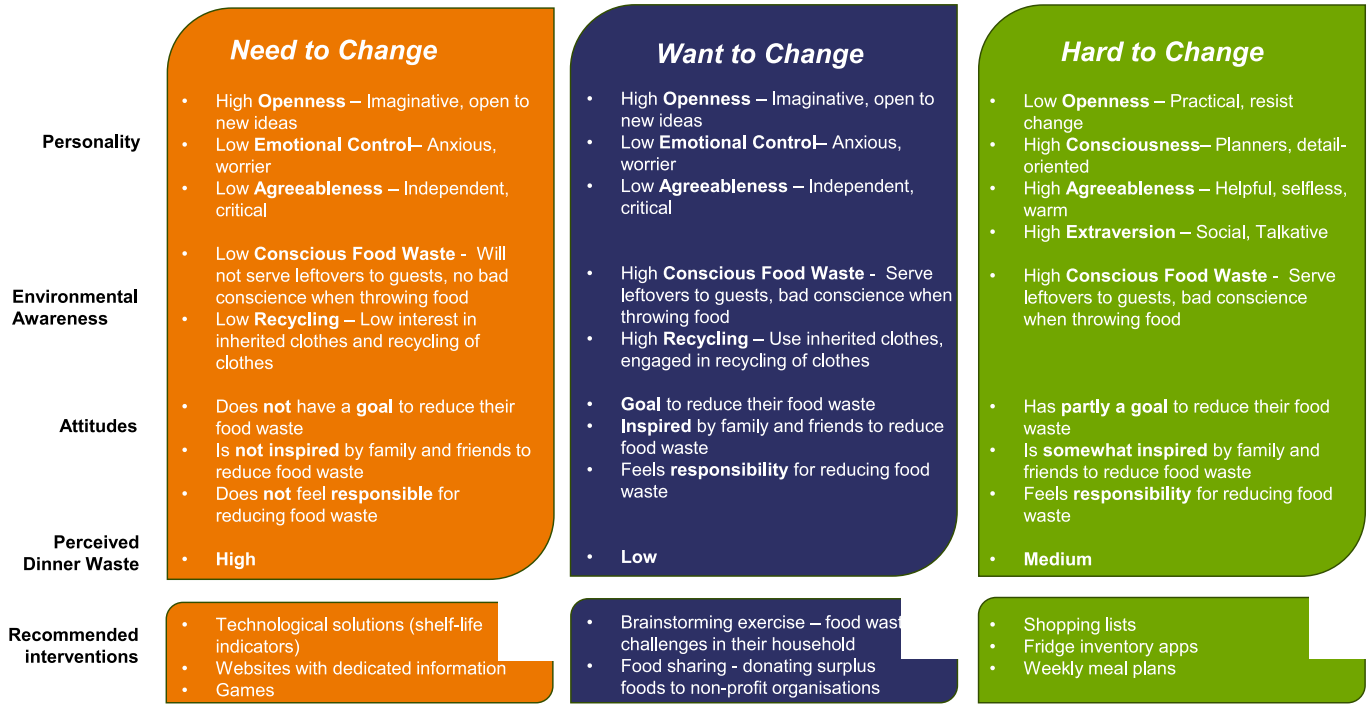

Fig. 5. Summary of the most salient traits and the recommended food waste interventions targeting the three different personality profiles: Need to Change, Want to Change and Hard to Change.

Change consumers (with high reported waste), 25 % more *Want to change* consumers (with low reported waste), and 15 % fewer *Hard to Change* consumers (with intermediate reported waste). Some explanations for this may be the self-enrolment bias for joining a food waste study, our focus on households with children, and our recruitment in a restricted geographical location. Nonetheless, this bias highlights the value of conducting a supervised classification rather than constructing new segments that may have only applied within our sample. Furthermore, our sample did not include many families with low income, and male respondents were in the minority. It would therefore be desirable in future studies to have a more even representation of Norwegian families both in terms of gender and family income.

Achieving behavioural change among consumers requires understanding specific segments that can succeed through an intervention program. Future research is needed to evaluate the success rate and sustained impact of diverse intervention strategies across consumer profiles.

4.4. Practical implications

This study makes two contributions to the food waste literature. First, it investigated the relationship between consumers' personality traits and their self-reported dinner food waste, attitudes, and environmental awareness, specifically targeting households with children. Second, it proposes intervention strategies targeted at each consumer profile and suggests which consumer profile is most important to reach to gain the most food waste reduction. This information might benefit national and international researchers and authorities when developing food waste interventions or campaigns.

5. Conclusion

The present study investigated the amount of perceived waste from prepared dinners and personality traits, environmental awareness, and attitudes towards food waste, with focus on households with children. Building upon three known consumer segments in the Norwegian population in terms of personality and environmental awareness – *Need to Change, Want to Change,* and *Hard to Change* – we profiled each segment in relation to self-reported dinner food waste and attitudes. The results suggest that personality traits could help design interventions against household food waste. Specifically, consumers in the *Need to Change* segment scored high on the 'Openness to Experience' personality trait, had low awareness of environmental issues and attitudes towards food waste, and were found to report the highest levels of food waste. Policymakers are recommended to target the *Need to Change* consumers (30 % of the respondents in our study and 40 % of a national representative population sample), because they feel no responsibility to contribute, yet have the highest potential to a significant impact on household food waste reduction. Future research is recommended with practical implementations of household interventions, to test the hypothesis that the success of a specific food waste reduction intervention may depend on consumers' personality traits.

Ethical Statement

The Norwegian Agency for Shared Services in Education and Research (Sikt) and Nofima's independent Ethical committee approved the study protocol before the data collection (Refnr. 775619).

CRediT authorship contribution statement

Kristine Svartebekk Myhrer: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mari Øvrum Gaarder:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Investigation, Funding acquisition, Formal analysis. **Ingunn Berget:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Valerie Lengard Almli:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2024.105231.

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