Innovation as an intervention: How being involved in innovations against food waste changes individuals' awareness, attitude, and behaviours towards food waste?

Nazli Koseoglu[1] & Simone Piras[1]
[1] Social, Economic & Geographical Sciences Department, The James Hutton Institute, Scotland UK.

Reducing food loss and waste requires a change in how consumers behave in public and in the privacy of their homes. Approaches requiring active involvement result in greater changes in attitudes and behaviour compared to passive interventions based on delivery of information. However, whether being involved in implementing innovations acts as an active intervention yet remains to be investigated. In this study, we investigate if being involved in the implementation of innovations against food waste increases awareness and improves the attitude and behaviour of participants towards wasting food. To this end, we ran surveys in workplaces, schools and households that have been testing innovations targeting food waste in the framework of Lowinfood, a European Horizon 2020 project. We discuss the change in responses between before and after implementation, and the degree of change comparatively across different demographics as well as innovation types. The results are important for improving our understanding the role of active participation in triggering change and increasing the social impact of European public funding.

1. Introduction

Food loss and waste results in significant misuse of resources to grow, harvest, transport, and pack food. In addition, wasted food have environmental and climatic consequences, especially when landfilled (Tonini et al., 2018). While in developing countries the highest losses occur in stages immediately after harvest, in developed countries consumer food waste accounts for the greatest loss category along the food supply chains (Parfitt et al., 2010). The average UK household annually throws away more than 25 per cent of its food purchase by weight (WRAP, 2008, 2009), and other consumer sources such as hospitality and institutional food services (e.g., canteens of workplaces, schools etc.) though not as well studied as households, are also hotspots of food waste. Understanding consumers' food waste in households and public settings, and raising consumer awareness against food waste is critical to initiate a move towards changing consumers' behaviour (Aydin & Yildirim, 2021).

Actively involving individuals and groups in interventions can act an effective way to promote desired attitudes and to change behaviours as a result. Albrecht et al. (2020) found that residents of neighborhoods where refugees had been settled have acquired more personal contacts with communities different from theirs compared to the rest of the population and as a result, have adopted, with time, a more positive opinion about minorities, refugees and emigration. Wallach (2004) observed that students that worked in or visited mental institutions as a part of their coursework had an improved awareness of and attitude towards mental illness patients at the end of their course compared to the rest of the psychopathology students, the scale and longevity of the improvements

being determined by the duration, frequency, and type of their interactions with the patients (Penny, 2002). Similarly, Greene (2013) concluded that involving school children in the design and implementation of campaigns against risk-taking behaviours acts as an active intervention and leads to sustainable change in attitude and behaviour of these groups towards risky activities such as smoking or using drugs.

Behavioural change can also be linked to the mere exposure, or familiarity effect. Zajonc (1968) assumes that repeated exposure alone leads to formation of attitude toward the stimulus. The individuals who receive information through minimal yet reinforced exposure, will instinctually attend to and be familiar with a stimulus, thereby exhibiting a direct attitudinal preference towards the stimulus, may this be a topic, object, or group of people (Ramasamy & Khodabakhsh, 2022). Therefore, we can equally hypothesise that through their involvements in innovations in their workplace or households alone, without any additional treatment over a period of time, individuals are exposed to the issue of food loss and waste and are familiarised with the issue.

We thus hypothesise that involvement in innovations tackling food waste acts like a form of intervention. Taking part in the implementation of innovations in workplaces or households can lead to increase in awareness and formation of negative attitude against food waste. We further hypothesise that improved awareness and changed attitudes then lead to behavioural change by individuals involved the innovation to reduce food waste. We explore whether certain demographic groups are more receptive to be influenced. We do so as part of a multi-country EU Horizon 2020 project, Lowinfood "Multi-actor design of low-waste food value chains through the demonstration of innovative solutions to reduce food loss and waste," which foresees the testing of different types of innovations in the fruit and vegetables, bread, and fish supply chains as well as at the consumption stage.

The literature shows that active involvement has a pronounced effect for workplace interventions (Chapman et al., 2013; Kersh, 2019). Workplaces provide space for wider exchange and participation, and the work life interface is permeable; individuals transfer knowledge and information they acquire at their workplaces to their household practices and vice versa (Cambra-Fierro et al., 2008). The research participants in Lowinfood project are adults of the working age, e.g., 16 and above, and they are expected to spend most of their days at work or at school. We examine how responses differ based on whether they come from a workplace-based or a household-based innovation, and how change in responses compare across different levels of participant involvement, demographics, and innovation types (e.g., technological, organisational, or social).

2. Background

We use the Theory of Planned Behaviour (Ajzen, 1991) in the design of surveys implemented before and after the implementation of the innovation, and in the analysis of the survey responses. This is to avoid the possible desirability bias in the responses of the involved staff and household members, which is found to characterise the food waste realm (Giordano et al., 2018), and have a more neutral representation of how the change in awareness and attitudes translates to behaviours.

The Theory of Planned Behaviour (TPB) (Ajzen, 1991) has commonly been used to identify the effect of interventions in creating pro-environmental behaviour change (Russell et al., 2017; Tonglet et al., 2004). In the analysis here, we brought in components from former conceptual models built on the TPB looking into food waste and recycling behaviour, and included the construct of situational factors (Tonglet et al., 2004) such as access to facilities at home and work for recycling food to control for the effect of the actual physical environment on the behavioural outcome.

3. Data and methods

To assess the impact of interventions on food waste behaviour, awareness and attitudes, we developed an online survey (hereafter "participant survey") to be disseminated among employees of the companies and members of the households implementing the Lowinfood innovations. The same survey was meant to be completed before ("baseline") and after the respondents had been involved in the implementation of the innovations ("post-implementation"). In line with the TPB practice, the constructs are generated using a multi-items Likert scale.

When constructing the survey, we first conducted a literature review of the previous studies that have used the TBP in their survey design to explore changes in pro-environmental behaviour as a result of interventions. We had a three separate cycle of review: first we had a meeting with four psychologists and one sociologist experienced in survey design who provided comments and suggestions. Then we had three individual test sessions to collect further feedback to improve participants' experience.

After the above review, we asked Lowinfood consortium members involved in the socioeconomic impact assessment task to review the survey to assess how the survey could be perceived across people from different disciplines and speaking different languages. This provided us with the opportunity to simplify and clarify the statements as much as possible before the survey was digitised and translated into local languages using the Qualtrics software. The final version of the Likert scale includes 33 statements to be assessed along five levels in terms of agreement, from "strongly agree" to "strongly disagree" (an opt-out option was not included; however, the mid-way option was "neutral", and the participants were not forced to rank all statements in order to proceed). The survey was reviewed and approved by the Research Ethics Committee of the James Hutton Institute to ensure that it complied with the ethics criteria for research on human subjects. With this final step, the participant survey template was finalised (See Appendix 1 for Participant survey template).

The last phase of the review took place with local academic partners involved in specific innovations as data controllers to customise the template. At this stage, we did not ask for content feedback as the same statements had to be used across countries and innovations for consistency of the data that would be collected. Local partners provided comments to the translation of the survey and provided task-specific modifications to the complementary questions, such as duration of implementation period and relevant periods of participant involvement in their innovation.

We have also formulated the statements and the wider questions as straightforward as possible, using a layperson language, because the surveys were translated in several local languages and administered across a diverse sample of respondents varying in aspects such as familiarity with the food and waste management concepts, age, and education levels. We chose proxies to avoid responses that are consciously or unconsciously biased due to social desirability and used a five-point Likert scale, from "strongly agree" to "strongly disagree", plus socio-demographic questions, and questions related to the role of the respondents in the company (where relevant), in the management of the innovation, and the duration of their involvement in the implementation.

3.1 Data

Survey data was collected from the users of the innovations tested in the scope of Lowinfood H2020 project aiming to combat food waste in the fruit and vegetable, bakery, and fish and seafood supply chains, as well as with end-consumers in the households and catering and tourism sectors. The innovations demonstrated varied in their implementation periods, number of test locations and countries they were tested in. Innovations targeted different stages of the supply chains and different

components of waste. The respondents were employees of the organisations (businesses and schools) and members of the households involved in the testing of innovations before and after the implementation periods. This is to analyse if and how being involved in various innovations impacted their baseline awareness of and attitude and behaviours against food loss and waste. Appendix 2 includes additional details about the innovations tested in Lowinfood.

To ensure confidentiality, we did not include an identifier of the individual respondent but rather of their organisation or household. This choice was also due to staff turnover: the respondents to the baseline survey were not necessarily the same as the post-implementation survey, although in most instances they likely were. Additionally, for some innovations it was not possible to obtain a baseline measurement from the implementing organisations because they had started using the innovation before the beginning of the Lowinfood project. In these cases, the baseline was constructed by disseminating the survey among employees of similar organisations. For these reasons, our dataset cannot be considered a proper panel.

Depending on the innovation, the baseline dissemination took place between the end of March 2022 and the beginning of November 2023; the post-implementation dissemination, between the end of May 2022 and the beginning of February 2024. The participants answered in their local language. In most instances, they were provided a QR code or a link to the Qualtrics survey and assigned an organisational identifier; in some cases (e.g., the CozZo app for households) the task leaders used another online data collection tool (e.g., Lime survey), or distributed paper surveys and entered the data in Qualtrics afterwards.

As of the end of February 2024, the sample size is 506, including 264 baseline and 242 post-implementation responses. An overview by innovation is provided in Table 1. Most responses (388) were obtained in the framework of innovations focused on consumers' behavioural change, followed by those targeting supply chain efficiency (79), those aimed at food redistribution (27), and finally food waste prevention governance actions (12). The household respondents are 117 (all those involved in the implementation of CozZo), the students 179 (150 involved in the Holistic Educational Approach and 29 in Matomatic), the employees 210. In terms of countries, Austria is the most represented with 242 responses, followed by Germany with 73, Sweden with 58, Greece with 54, Finland with 43, Italy with 27, and the United Kingdom and Romania with five and four, respectively. Given the small sample sizes in some instances, it is not possible to implement separate analyses for all innovations.

Table 1. Distribution of survey responses by innovation, innovation type, and phase.

Innovation type	Innovation	Baseline	Post-impl.	Total
Food waste prevention governance	Bakery stakeholder dialogue[3]	0	7	7
	Fish stakeholder dialogue	5	0	5
Consumer behavioural change	Cozzo[1]	60	57	117
	Holistic Educational Approach[2]	113	88	201
	Matomatic[2]	25	45	70
Supply chain efficiency	Kitro	30	16	46
	Sales forecasting	2	0	2
	FoodTracks	17	6	23
	Mitakus	5	3	8
Food redistribution actions	RER[3]	4	7	11
	Regusto	7	5	12
	Unverschwendet	0	4	4
Total		268	238	506

Notes: [1] All households; [2] Partly students, partly employees; [3] Implementation ongoing.

3.2 Data analysis

The analysis follows three steps. First, we implement *t*-tests to assess the change in the level of agreement with the single statements between the baseline and the post-implementation phases among the participants involved in the implementation of innovations of the same typology. We omit the category of food waste prevention governance because of the small sample size and the fact that the baseline and post-implementation responses come from different innovations and countries. Second, we generate aggregate indicators corresponding to the constructs of our theoretical model,[1] and test statistically if these indicators have changed between before and after implementation for specific demographic categories. These categories are the different genders (female or male[2]), ages (up to 34, or 35 and more) and levels of education (university *vs* lower): they were turned into binary for sample size reasons.

As a last step, we estimate Structural Equation Models (SEM) (Rabe-Hesketh et al., 2004) using the baseline and postimplementation responses in turn and obtaining the various constructs endogenously as latent dependent variables. This third steps allows to assess whether, besides the value assumed by the constructs, also the interrelations between different constructs were affected by the involvement in the innovations, e.g., becoming stronger, weaker, or changing direction. We do not include any additional controls in the SEM models to avoid reducing our degrees of freedom and because preliminary estimation initial attempts revealed convergence problems; in turn, we cluster the standard errors at the level of organisation (or household) of the participant. The statements and their grouping are illustrated in Table 2.

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[1] Despite several attempts to obtain the constructs endogenously by means of Principal Component Analysis and factor analysis, no significant dimensionality reduction could be achieved. Therefore, the structure of the model was imposed a priori, and the Cronbach's alpha was calculated to assess internal consistency. Seven out of 33 statements were removed (not included in any construct) to improve the coherence of the constructs.

[2] Fifteen respondents either did not indicate a gender or preferred to self-describe: these numbers are too small to implement a separate analysis.

Table 2. Statements grouped by construct, and value of the Cronbach's alpha.

Construct	Variable name	Statement	Cronbach's alpha
Attitude	waste_quan	Everyday huge quantities of food are wasted in the world	0.803
	planet	The daily amount of food waste is a serious problem for the planet	
	economic	Food waste is a major economic issue	
	resources	Wasting food is wasting other resources such as water and energy	
	waste_inevi	Wasting food at home is inevitable (*reversed item*) (*not used in the construct*)	n.a.
	waste_impos	It is impossible to avoid food waste at workplace (*reversed item*) (*not used in the construct*)	
Moral concern	worry	The problem of food waste worries me a lot	0.777
	waste_irres	Wasting food is irresponsible	
	guilty	When I waste food, I feel guilty	
	responsible	Everybody has a responsibility to reduce food waste	
	principle	Wasting food does not go against my principles (*reversed item*) (*not used in the construct*)	n.a.
Subjective norm	socie_care	Many people in our society do not care about their food waste	0.566
	hh_support	My household supports my efforts to reduce food waste at home	
	colleagues	My colleagues support my efforts to reduce food waste at work	
	pressure	I feel social/peer pressure to avoid wasting food (*not used in the construct*)	n.a.
Perceived behavioural control (PBC)	know_hh	I know what to do to reduce food waste at home	0.784
	know_eatout	I know what to do to reduce food waste when I eat out	
	know_restaur	I know what to do to reduce my food waste when eating at a restaurant	
	know_work	I know what to do to reduce food waste at work	
	control_wp	I have control over the amount of food waste produced in my workplace	
	control_hh	I have control over the amount of food waste produced in my household	
	recycle	I have the ability to recycle my unavoidable food waste such as the inedible peels, pits and stones of fruits and vegetables, bones in meat and fish etc. (*not used in the construct*)	n.a.
Intention	not_care	I do not care if I waste food (*reversed item*)	0.736
	waste_hh	I am committed to reducing food waste in my household	
	waste_work	I am committed to reducing food waste in my workplace	
Situational factors	hassle_hh	Reducing food waste in my household is a hassle (*reversed item*)	0.771
	waste_time	Reducing food waste requires a lot of time (*reversed item*)	
	waste_tech	To reduce the food waste in my household I need to buy new equipment/new technology (*reversed item*)	
	council	The local council provides satisfactory resources for recycling food waste (*not used in the construct*)	n.a.
	recycle_wp	My workplace provides satisfactory resources to recycle food waste (*not used in the construct*)	
Behaviour	food_spoil	I regularly throw away food that I could have consumed due to food spoiling (*reversed item*)	0.389
	rarely_waste	I seldom throw away food that could have been eaten because I have bought too much	
	prepare_waste	I sometimes throw away food that could have been eaten because I have prepared too much food (*reversed item*)	

Notes: The statements marked as "*reversed item*" were reversed before creating the construct, if retained. The statements marked as "*not used in the construct*" were not used in the building of the construct to increase internal consistency.

Conventionally, 0.7 is deemed the minimum acceptable level of the Cronbach's alpha. Unfortunately, despite several attempts and removal of some statements which showed a lower correlation with the others, this value could not be achieved for the constructs "subjective norms" (0.57) and "behaviour" (0.39). Hence, any results based on these constructs must be considered with care. It is also worth mentioning that behaviours are self-declared and are thus subject to social desirability bias (Giordano et al., 2019). Furthermore, before being aggregated to facilitate the reading of the results, some statements were reversed: consequently, higher levels of the constructs always indicate a situation more favourable to food waste reduction (more virtuous behaviours and intentions, higher perceived behavioural control -PBC-, etc.).

All the estimates were implemented using Stata15 (Stata Corp, 2017) and the `sem` command for the SEMs (Stata Corp, 2023).

4. Results and discussions

As a first step, we test the change in the level of agreement with the various Likert-scale statements between before and after the implementation of the innovations.[3] The results are displayed in Table 3 for the innovations focusing on "consumer behavioural change," "supply chain efficiency," and "food redistribution," respectively, while the fourth category is omitted because of the small samples size. Preliminarily, it is worth mentioning that while the participants' responses are subject to a "social desirability bias," there is no reason to believe that the bias has affected one of the two phases more net of involvement in the innovation. Instead, if the participants have increased their awareness and concerns for food waste as a result of this "treatment," this is a desirable outcome that our surveys will measure.

Table 3. Difference in assessment of the statements between baseline and post-implementation survey, by innovation type.

Statement	Hypothesis[1]	Consumer behavioural change			Supply chain efficiency			Food redistribution actions		
		Baseline	Post-impl.	*p*-value[2]	Baseline	Post-impl.	*p*-value[2]	Baseline	Post-impl.	*p*-value[2]
waste_quan	+	4.57	4.56	0.510	4.57	4.72	0.259	4.00	4.38	0.233
planet	+	4.39	4.46	0.220	4.53	4.67	0.229	4.55	4.44	0.662
economic	+	4.23	4.23	0.523	4.60	4.79	0.131	4.27	4.25	0.524
resources	+	4.49	4.49	0.525	4.64	4.79	0.191	4.09	4.31	0.278
waste_inevi	-	2.60	2.49	0.168	2.59	2.60	0.509	2.09	1.94	0.339
waste_impos	-	2.59	2.65	0.666	2.93	3.24	0.818	1.82	2.00	0.681
worry	+	3.82	3.86	0.325	4.26	4.64	0.037**	4.45	3.94	0.889
waste_irres	+	4.03	4.21	0.051*	4.09	4.44	0.080*	4.64	4.38	0.767
guilty	+	4.05	4.05	0.492	4.17	4.52	0.065*	4.36	4.44	0.403
responsible	+	4.44	4.47	0.331	4.53	4.84	0.049**	4.45	4.60	0.339
principle	-	2.51	2.27	0.039**	2.33	1.96	0.125	1.45	1.69	0.733
socie_care	+	3.94	3.89	0.679	4.11	4.25	0.293	3.73	4.19	0.104
hh_support	+	3.94	3.89	0.696	4.29	4.50	0.165	3.64	4.00	0.205
colleagues	+	3.27	3.44	0.071*	4.19	4.38	0.211	3.73	3.88	0.357
pressure	+	2.96	2.91	0.661	2.77	3.04	0.194	3.27	2.63	0.948†
know_hh	+	4.03	4.13	0.178	4.36	4.65	0.081*	3.91	4.06	0.357
know_eatout	+	3.79	3.90	0.159	4.02	4.39	0.081*	4.09	3.56	0.875
know_restaur	+	3.88	3.95	0.273	4.06	4.30	0.171	4.18	3.38	0.948†
know_work	+	3.79	3.76	0.625	4.26	4.65	0.028**	4.18	3.94	0.762
control_wp	+	3.05	2.83	0.957†	3.68	3.73	0.429	3.73	2.75	0.962†
control_hh	+	3.79	3.90	0.128	4.29	4.27	0.528	4.18	4.13	0.559
recycle	+	3.13	3.20	0.291	3.66	3.32	0.842	3.00	3.19	0.372
not_care	-	1.50	1.56	0.744	1.37	1.21	0.195	1.27	1.31	0.584
waste_hh	+	3.98	4.06	0.220	4.49	4.71	0.137	4.55	4.50	0.577
waste_work	+	3.69	3.78	0.192	4.42	4.79	0.035**	4.55	4.44	0.639
hassle_hh	-	2.47	2.52	0.698	2.24	2.41	0.702	1.73	2.06	0.799
waste_time	-	2.51	2.60	0.783	1.92	2.23	0.844	2.73	2.25	0.181
waste_tech	?	1.98	2.04	0.634	2.18	1.86	0.314	2.64	2.19	0.328
council	?	2.89	3.05	0.206	3.24	3.18	0.875	2.00	3.19	0.022**
recycle_wp	?	2.93	3.13	0.142	3.96	3.68	0.358	3.64	3.13	0.357
food_spoil	-	2.69	2.49	0.042**	2.57	2.22	0.133	2.45	2.44	0.486
rarely_waste	+	3.44	3.53	0.229	3.82	4.08	0.176	3.64	3.81	0.361
prepare_waste	?	2.32	2.41	0.458	2.29	2.65	0.240	2.82	2.38	0.188

Notes: [1] Direction of the hypothesis: **+** indicates an expected increase in the value of the indicator between the baseline and post-implementation surveys; **-** an expected decrease; **?** no expected change. [2] In case of increase or decrease, the *p*-values refer to a monodirectional *t*-test; in case of no expected change, to a bidirectional *t*-test. Significance levels: *** 0.01, ** 0.05, * 0.10. **†** Significant change in the opposite direction.

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[3] The numbers of observations for specific statements and constructs can deviate from those reported in because the participants were not forced to assess all the statements and might have skipped some of them.

First, most statements show no significant change between the baseline and post-implementation survey. The significant changes are concentrated in the statements pertaining to "moral concern" and, to a lesser extent, "perceived behavioural control", and are usually driven by being involved in innovations dealing with supply chain efficiency, i.e., among employees, followed by those focused on consumers' behavioural change, i.e., households and students. As a result of involvement, the participants feel more responsibility towards food waste reduction, and are confident of their ability to address food waste in various contexts, including households and workplaces.

Noteworthy, the participants involved in supply chain efficiency innovations strengthen their intention to reduce food waste at work. Instead, food redistribution actions seem not to generate significant impact, with the level of agreement with some statements moving in the opposite direction instead. Interestingly, the respondents seem to lose confidence in their ability to address food waste in their workplace.

As a second step, to reduce complexity, we aggregate the statements according to the constructs of our theoretical model, and assess if the levels of agreement with these constructs have changed significantly between before and after implementation of the innovations, first for the three innovation typologies, and then for specific socio-demographic groups in turn. As a result of aggregation, the values of the constructs are centred on zero and, depending on the construct, range between -3.91 and 1.22. We do not report the actual values since we focus on change. The impact by innovation typology, reported in Table 4, confirms the above findings: the participants involved in improving supply chain efficiency, see an increase in their moral concern for food waste as well as in their ability to address the issue in various contexts (PBC).

The changes in the other constructs, or as a result of being involved in other innovation types are not significant. In turn, none of the constructs, for none of the innovation types, changes in a direction opposite to expectations. It is also worth highlighting that the baseline assessment of the constructs differs between participants involved in different innovation types, with consumer behaviour innovations being associated with opinions less "favourable" to food waste reduction, followed by food redistribution actions and, finally, supply chain efficiency participants.

In terms of socio-demographic categories, we first assess the significance of changes for specific groups of participants (employees, household members, and students). As shown in Table 5, the category that experiences the most significant and positive changes are household members: their attitude and moral concern towards food waste both improve, as do their intention to reduce food waste and the resulting self-declared behaviours. Employees see a raise in moral concern and intention. In turn, students experience a change of their attitude, intention and behaviour in directions opposite to expectations, and no positive changes in any of the constructs. It is also worth mentioning that students start from the least favourable values of the constructs (all below zero), opposite to employees who had favourable values from the start (all positive).

In Appendix 3, we report *t*-tests of the differences in the single statements, which broadly confirm the above results in terms of constructs: the best outcomes are achieved among households, the worst among students. Hence, we can argue that when an innovation is tested at home, participants are probably more emotionally involved, and the actions and topics entailed in the demonstration have repercussions on their wider food-related behavioural planning; instead, the testing of innovations among secondary school students does not seem to have an impact on their wider food waste-related attitudes and behaviours beyond school. This confirms what already found by Piras et al. (2023) when analysing the impact of environmental education in primary schools, that there are no spill-overs to food waste behaviour at home. Employees occupy a mid-way position, with the impact

likely mediated by their concrete role in the organisation, and thus their involvement in the management of food.

Finally, Table 6 illustrates the change among socio-demographic groups, namely different genders, age groups, and levels of education. The number of female participants is more than double that of males, and compared to males, their baseline values are more favourable to food waste reduction for all the constructs apart from behaviours. In turn, behaviours see a significant improvement among females, while males experience an improvement in attitudes and moral concern. In terms of age, young respondents see no significant change, while older ones see an improvement in subjective norms only. Furthermore, the participants with education lower than university level see no improvement in any of the constructs, while those with high education experience a significant improvement in their confidence in their ability to address the issue (PBC), situational factors, and subjective norms.

We won't expect any improvement in situational factors given that they are exogenous to the respondent unless the latter perceive that the availability of the innovation (especially technological ones) makes a difference for their workplace or household. It is also important to highlight that young participants start from baseline values which are below the baseline for older participants for all the constructs, while the participants with low education start from baseline values that are below those of highly educated people for all the constructs apart from subjective norms.

Appendix 3 confirms the above dynamics, and particularly the limited impact of the innovations among participants with low education, in addition to students. Hence, there is a need to focus particularly on these categories (males, young, and low educated consumers) in order to achieve a real change towards low-waste behaviour, since they seem to be more resistant to change.

Table 4. Difference in assessment of the constructs between baseline and post-implementation survey, by innovation type.

Construct	Consumer behavioural change			Supply chain efficiency			Food redistribution actions		
	Baseline	Post-impl.	*p*-value	Baseline	Post-impl.	*p*-value	Baseline	Post-impl.	*p*-value
Attitude	-0.04	-0.03	0.464	0.16	0.32	0.182	-0.25	-0.13	0.344
Behaviour	-0.05	0.01	0.204	0.12	0.16	0.425	-0.07	0.11	0.266
Intention	-0.14	-0.12	0.403	0.33	0.58	0.083*	0.42	0.35	0.612
Moral concern	-0.10	-0.03	0.174	0.10	0.45	0.026**	0.30	0.27	0.530
PBC	-0.08	-0.06	0.374	0.29	0.48	0.128	0.22	-0.14	0.895
Situational factors	-0.02	-0.08	0.762	0.16	0.11	0.585	-0.04	0.12	0.310
Subjective norm	-0.10	-0.10	0.550	0.35	0.50	0.169	-0.14	0.17	0.174

Notes: We expect an increase in all the constructs; thus, the *p*-values refer to a monodirectional *t*-test. Significance levels: *** 0.01, ** 0.05, * 0.10. No significant change in the opposite direction were detected.

Table 5. Difference in assessment of the constructs between baseline and post-implementation survey, by participant type.

Construct	Employees (n = 210)			Households (n = 117)			Students (n = 179)		
	Baseline	Post-impl.	*p*-value	Baseline	Post-impl.	*p*-value	Baseline	Post-impl.	*p*-value
Attitude	0.10	0.22	0.114	0.16	0.38	0.027**	-0.27	-0.48	0.946†
Behaviour	0.03	0.10	0.234	0.02	0.29	0.029**	-0.12	-0.24	0.905†
Intention	0.27	0.45	0.036**	0.01	0.20	0.080*	-0.35	-0.62	0.993†
Moral concern	0.16	0.33	0.036**	0.13	0.36	0.014**	-0.40	-0.49	0.765
PBC	0.24	0.27	0.384	-0.06	0.00	0.316	-0.26	-0.31	0.727
Situational factors	0.26	0.17	0.765	0.00	0.07	0.329	-0.23	-0.33	0.802
Subjective norm	0.25	0.33	0.214	-0.14	-0.15	0.536	-0.21	-0.30	0.813

Notes: We expect an increase in all the constructs; thus, the *p*-values refer to a monodirectional *t*-test. Significance levels: *** 0.01, ** 0.05, * 0.10. † Significant change in the opposite direction.

Table 6. Difference in assessment of the constructs between baseline and post implementation survey, by socio-demographic characteristics.

Construct	Female (n = 327)			Male (n = 164)			Young (n = 285)			Old (n = 221)			Low education (n = 333)			High education (n = 173)		
	Basel.	Post-impl.	*p*-value	Basel.	Post-impl.	*p*-value	Basel.	Post-impl.	*p*-value	Basel.	Post-impl.	*p*-value	Basel.	Post-impl.	*p*-value	Basel.	Post-impl.	*p*-value
Attitude	0.09	0.08	0.544	-0.22	0.04	0.025**	-0.14	-0.19	0.693	0.29	0.15	0.899	-0.06	-0.13	0.758	0.14	0.14	0.532
Behaviour	-0.06	0.09	0.024**	0.04	-0.02	0.704	-0.08	-0.06	0.390	0.23	0.24	0.453	-0.01	-0.10	0.873	0.06	0.09	0.381
Intention	0.07	0.11	0.325	-0.17	-0.06	0.227	-0.25	-0.32	0.748	0.19	0.24	0.279	-0.08	-0.14	0.722	-0.08	0.02	0.190
Moral concern	0.07	0.13	0.200	-0.28	0.00	0.024**	-0.24	-0.19	0.314	0.34	0.40	0.259	-0.13	-0.09	0.299	0.14	0.27	0.105
PBC	0.02	0.04	0.404	-0.05	-0.01	0.369	-0.17	-0.19	0.605	0.05	0.13	0.189	-0.04	-0.04	0.526	0.12	0.30	0.035**
Situational factors	0.04	0.04	0.481	-0.01	-0.05	0.605	-0.18	-0.17	0.466	0.16	0.25	0.143	-0.04	-0.11	0.764	0.08	0.27	0.022**
Subjective norm	0.06	0.05	0.548	-0.13	-0.02	0.190	-0.14	-0.21	0.788	0.22	0.34	0.077*	0.03	-0.01	0.677	-0.06	0.25	0.002***

Notes: We expect an increase in all the constructs; thus, the *p*-values refer to a monodirectional t-test. Significance levels: *** 0.01, ** 0.05, * 0.10. No significant change in the opposite direction were detected.

As a final step, we estimate SEMs to assess if the involvement in the demonstration of innovations may have driven a change in the relationship between constructs, and thus in the dynamics underlying food waste behaviour. We estimate exactly the same model first using the baseline responses, and then using the post-implementation ones. The values of the standardized root mean squared residuals (SRMR) indicate a good fit for the baseline model, while the post-implementation model is slightly above the conventional threshold of 0.08. In turn, the coefficient of determination (CD) is equal to 1.000 for both model, after rounding, which indicates a good fit.

The sample size is smaller than the number of survey respondents because the participants who skipped at least one statement are omitted. Before running the models, all the statements whose direction was "negative" were reversed, to facilitate the interpretation of the results. Consequently, we would expect all the relationships between the constructs, illustrated in Figure 1, to be positive: attitudes and subjective norms more favourable to food waste reduction, stronger moral concerns for food waste, and higher PBC are all expected to lead to higher intention to address food waste which, together with more favourable situational factors, results in behaviours more favourable to food waste reduction. The indirect effects are also expected to be positive and significant.

Figure 1. Structure of the SEM estimated.
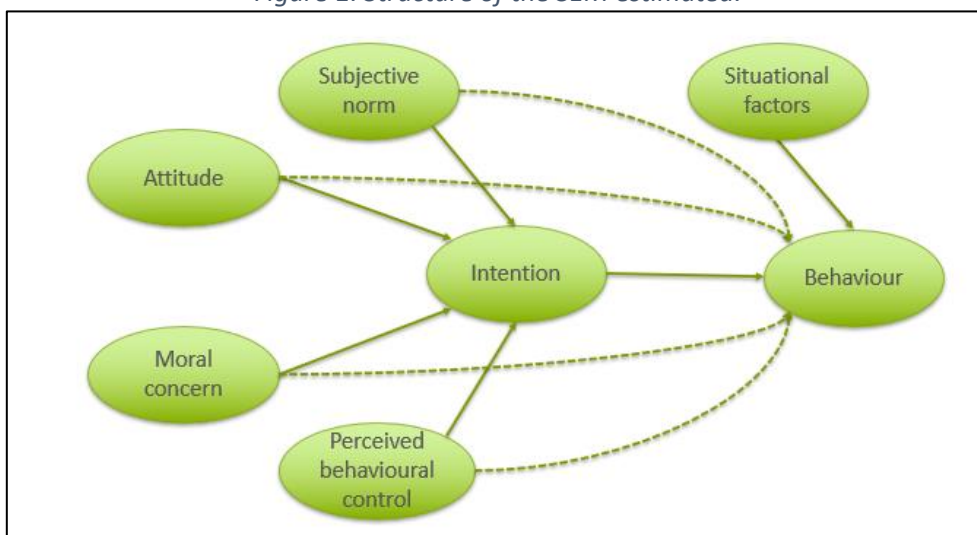
Notes: All the constructs in the ovals were estimated as latent variables starting from the statements (26 retained, seven omitted, as specified in Table). The continuous lines represent direct effects, entailed in the equations on the SEM; the dashed lines, indirect effects.

As shown in Table7, the results in terms of coefficients of the model change between the baseline and the post-implementation phase. Because all the constructs have a similar scale, we can directly compare the coefficients. In the baseline model, Attitude has a positive and significant impact on Intention, in line with our hypothesis. However, Moral concern and Subjective norm have negative and significant impact, larger for the latter, and PBC is not significantly related to Intention: such figures contradict our hypotheses. Nevertheless, all these relationships become non-significant after implementation of the innovations. As for the constructs affecting (self-declared) Behaviour, we observe a significant positive impact of Situational factors which is preserves across phases but becomes smaller. Instead, Intention, non-significant before implementation, becomes positive and significant afterwards, although its impact is smaller than Situational factors. Finally, none of the indirect effects are significant in either of the phases.

The above results suggest that the external conditions faced by participants (Situational factors) matter for their food waste Behaviour, since they can hinder or favour the translation of Intentions: this pattern is not affected by our innovations. In turn, for similar Situational factors, being involved in implementing the innovations seems to have strengthened the relationship between Intention and Behaviour. At the same time, the relationships between Moral concern and Subjective norms on the one side, and Intention on the other, changes from being opposite to expectations to being non-significant. This suggests that there is an ungluing between stated ethical, environmental, and social concerns for food waste, and the willingness to act for addressing this challenge, with more concerned consumers initially less willing to take responsibility. While being involved in implementing our innovations was not enough to reverse the "cognitive dissonance" already highlighted in the food waste literature (Piras et al., 2022), still it seems to have shaken the counterintuitive relationship detected in the baseline phase, possibly starting a movement towards the opposite direction. It remains to be verified if longer exposure to the innovations could result in a direct relationship between the four constructs on the one hand, and the Intention to reduce food waste on the other.

Table7. Structural Equation Models estimated on the baseline and post-implementation samples.

Dependent variable & explanatory variables	Baseline SEM	Post-impl. SEM
Dependent variable: Intention		
Attitude	0.605*	-0.547
Moral concern	-0.579**	0.898
Subjective norm	-0.971***	-2.970
Perceived behavioural control	-0.039	0.438
Dependent variable: Behaviour		
Intention	0.327	0.266**
Situational factors	0.503***	0.367***
Latent variable: Attitude		
waste_quan	1.000	1.000
Constant term	4.535***	4.643***
planet	1.218***	1.825***
Constant term	4.456***	4.495***
economic	1.375***	1.598***
Constant term	4.328***	4.305***
resources	1.341***	1.888***
Constant term	4.506***	4.514***
Latent variable: Moral concern		
worry	1.000	1.000
Constant term	3.938***	3.976***
waste_irres	0.975***	0.890***
Constant term	4.087***	4.286***
guilty	1.246***	0.991***
Constant term	4.087***	4.129***
responsible	1.038***	0.886***
Constant term	4.490***	4.543***
Latent variable: Subjective norm		
socie_care	1.000	1.000
Constant term	4.000***	3.976***
hh_support	1.886***	1.585***
Constant term	4.033***	3.967***
colleagues	1.188***	1.664***
Constant term	3.519***	3.624***
Latent variable: Perceived behavioural control		
know_hh	1.000	1.000
Constant term	4.104***	4.190***
know_eatout	1.296***	1.084***
Constant term	3.822***	3.938***
know_restaur	1.139***	1.048***
Constant term	3.929***	3.938***
know_work	0.925***	1.173***
Constant term	3.896***	3.890***
control_wp	0.737***	0.450**
Constant term	3.203***	2.971***
control_hh	0.752***	0.708***
Constant term	3.884***	3.971***
Latent variable: Intention		
not_care	1.000	1.000
Constant term	1.452***	1.510***
waste_hh	-1.652***	-1.249***

Constant term	4.120***	4.200***
waste_work	-1.648***	-1.216***
Constant term	3.909***	3.981***
Latent variable: Situational factors		
hassle_hh	1.000	1.000
Constant term	2.415***	2.467***
waste_time	1.187***	1.332***
Constant term	2.411***	2.519***
waste_tech	0.890***	1.063***
Constant term	2.025***	1.995***
Latent variable: Behaviour		
food_spoil	1.000	1.000
Constant term	2.685***	2.457***
rarely_waste	-0.352**	-0.941***
Constant term	3.519***	3.548***
prepare_waste	0.975***	1.446***
Constant term	2.349***	2.471***
Indirect effects		
Attitude → Behaviour	0.198	0.146
Moral concern → Behaviour	-0.189	-0.239
Subjective norm → Behaviour	-0.317	0.791
Perceived behavioural control → Behaviour	-0.013	-0.117
Sample size	241	210
Log-likelihood	-7,918.52	-6,862.76
AIC	16,021.04	13,895.52
BIC	16,341.64	14,180.02
Standardized root mean squared residual (SRMR)	0.079	0.084
Coefficient of determination (CD)	1.000	1.000

5. Conclusions

The results show that the innovations had a mostly positive impact on those who were involved in their implementation, stronger in some constructs and among some demographics than in others. The improvement in behaviour among women, in subjective norms among older participants, and in perceived behavioural control among participants with high education are conspicuous. However, these were the groups with higher baseline values and due to their initial inclination towards food waste reduction, they are expected to be more receptive to the information they indirectly received through their participation (Abrahamse, 2020). The varying impact of innovation types on the different participant profiles indicates that improving food waste behaviour needs interventions targeting different demographics groups separately. This study provides some early insights about what type of individuals and households would be most susceptible to being positively influenced by participating in the implementation of certain type of innovations, and which ones would require more effort.

EU-funded projects aim to create added social benefits to European citizens and communities. The overall positive impact of the innovations on the participants highlights that the funds provided to the EU Horizon Innovation Action projects to test innovations have an indirect social benefit by creating awareness and behaviour change beyond their intended outcome of advancing the technological readiness level of the tested innovations. The findings here provide a starting point for further research to fully account for, and improve, the social value and impact created by the EU research funding.

The primary data collected in this study being obtained through surveys poses a minor issue. The self-declared nature of the data might not exactly reflect actual intention and behaviour. However, we focus on change (how the interventions affected actual behaviour or habits), which reduces the relevance of the social desirability bias. In the future, combining these results with measurements and composition of food waste before and after the innovations where available (for instance, at household level, while within companies it is not possible to disentangle impact of individual behaviours on the collective outcome), would provide further insights about actual behaviour and how it compares with participants' self-reporting.

Acknowledgements

References

Abrahamse, W. (2020). How to Effectively Encourage Sustainable Food Choices: A Mini-Review of Available Evidence. *Frontiers in Psychology*, *11*(November). https://doi.org/10.3389/fpsyg.2020.589674

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Albrecht, S., Ghidoni, R., Albrecht, S., Ghidoni, R., & Cettolin, E. (2020). *Exposure to ethnic minorities changes attitudes to them*. https://ssrn.com/abstract=3683776

Aydin, A. E., & Yildirim, P. (2021). Understanding food waste behavior: The role of morals, habits and knowledge. *Journal of Cleaner Production*, *280*, 124250. https://doi.org/10.1016/j.jclepro.2020.124250

Cambra-Fierro, J., Polo-Redondo, Y., & Wilson, A. (2008). The Influence of an Organisation's Corporate Values on Employees Personal Buying Behaviour. *Journal of Business Ethics*, *81*(1), 157–167. https://doi.org/10.1007/s10551-007-9486-1

Chapman, J., Skinner, N., & Searle, S. (2013). Working towards sustainability: Exploring the workplace as a site for pro-environmental behaviour change. In R. Crocker & S. Lehmann (Eds.), *Sustainable Design and Behaviour in the Built Environment* (pp. 10–12). Routledge. http://www.google.pl/patents/US5668099.pdf

Giordano, C., Alboni, F., & Falasconi, L. (2019). Quantities, determinants, and awareness of households' food waste in Italy: A comparison between diary and questionnaires quantities. *Sustainability (Switzerland)*, *11*(12). https://doi.org/10.3390/su11123381

Giordano, C., Piras, S., Boschini, M., & Falasconi, L. (2018). Are questionnaires a reliable method to measure food waste? A pilot study on Italian households. *British Food Journal*, *120*(12), 2885–2897. https://doi.org/DOI:10.1108/BFJ-02-2018-0081

Greene, K. (2013). The Theory of Active Involvement: Processes Underlying Interventions That Engage Adolescents in Message Planning and/or Production. *Health Communication*, *28*(7), 644–656. https://doi.org/10.1080/10410236.2012.762824

Kersh, N. (2019). Learning from knowledge transfer and recontextualisation of experiences in the context of workplace learning: Insights from the UK. *In: Bahl, A and Dietzen, A, (Eds.) Work-Based Learning as a Pathway to Competence-Based Education. (Pp. 255-272). Federal Institute for Vocational Education and Training: Bonn. (2019)* . https://www.bibb.de/veroeffentlichungen/en/publication/show/9861

Parfitt, J., Barthel, M., & MacNaughton, S. (2010). Food waste within food supply chains:

Quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 3065–3081. https://doi.org/10.1098/rstb.2010.0126

Penny, N. H. (2002). Longitudinal Study of Student Attitudes Toward People with Mental Illness. *Occupational Therapy in Mental Health*, *17*(2), 49–80. https://doi.org/10.1300/J004v17n02_04

Piras, S., Righi, S., Banchelli, F., Giordano, C., & Setti, M. (2023). Food waste between environmental education, peers, and family influence. Insights from primary school students in Northern Italy. *Journal of Cleaner Production*, *383*(November 2022), 135461. https://doi.org/10.1016/j.jclepro.2022.135461

Piras, S., Righi, S., Setti, M., Koseoglu, N., Grainger, M. J., Stewart, G. B., & Vittuari, M. (2022). From social interactions to private environmental behaviours: The case of consumer food waste. *Resources, Conservation and Recycling*, *176*(June 2020), 105952. https://doi.org/10.1016/j.resconrec.2021.105952

Rabe-Hesketh, S., Skrondal, A., & Pickles, A. (2004). Generalized multilevel structural equation modeling. *Psychometrika*, *69*(2), 167–190. https://doi.org/10.1007/BF02295939

Ramasamy, S., & Khodabakhsh, S. (2022). Subliminal mere exposure effects on the ageist attitude change among young adults. *SEARCH Journal of Media and Communication Research*, *14*(1), 109–118.

Russell, S. V., Young, C. W., Unsworth, K. L., & Robinson, C. (2017). Bringing habits and emotions into food waste behaviour. *Resources, Conservation and Recycling*, *125*(March), 107–114. https://doi.org/10.1016/j.resconrec.2017.06.007

Stata Corp. (2017). *Stata Statistical Software: Release 15*.

Stata Corp. (2023). *Stata 18: Structural Equation Modeling Reference Manual*.

Tonglet, M., Phillips, P. S., & Read, A. D. (2004). Using the Theory of Planned Behaviour to investigate the determinants of recycling behaviour: A case study from Brixworth, UK. *Resources, Conservation and Recycling*, *41*(3), 191–214. https://doi.org/10.1016/j.resconrec.2003.11.001

Tonini, D., Albizzati, P. F., & Astrup, T. F. (2018). Environmental impacts of food waste: Learnings and challenges from a case study on UK. *Waste Management*, *76*, 744–766. https://doi.org/10.1016/j.wasman.2018.03.032

Wallach, H. S. (2004). Changes in attitudes towards mental illness following exposure. *Community Mental Health Journal*, *40*(3), 235–248. https://doi.org/10.1023/B:COMH.0000026997.92083.4d

WRAP. (2008). The food we waste. In *Food waste Report V2* (Vol. 2, Issue July). http://library.wur.nl/WebQuery/clc/1944512

WRAP. (2009). *Household food and drink waste in the UK: Final report* (T. Quested & H. Johnson (eds.); Issue November). https://wrap.org.uk/resources/report/household-food-and-drink-waste-uk-2009

Zajonc, R. B. (1968). Attitudinal Effects of Mere Exposure. *Journal of Personality and Social Psychology*, *9*(2 PART 2), 1–27. https://doi.org/10.1037/h0025848

Appendix 1- Participant survey template

LOWINFOOD project end-user organisation staff survey

The LOWINFOOD is an EU-funded multi-actor design of low-waste food value supply chains through the demonstration of innovative solutions to reduce food loss and waste. The project implements different types of innovations, evaluating their potential to solve the food waste problem in the EU. (***Insert the name of relevant innovation in each separate link***) is one such innovation and we want to evaluate its impact on sustainability. We also want to assess any changes in the awareness, attitudes, and behaviours towards food waste, amongst those involved during (***Insert the name of relevant innovation in each separate link***) implementation. To determine these factors, we kindly request your participation in this survey since you have been actively involved with (***Insert the name of relevant innovation in each separate link***) during its implementation. We would appreciate your responses to the questions below that will be used in the social impact analysis of the innovations and for providing further insights to the European Commission.

CONFIDENTIALITY/PERSONAL DATA
Once the survey is finalised, the answers will be stored initially with Qualtrics in a password protected electronic format in an institute drive dedicated to the project. Data will later be downloaded and stored on a secure server of the James Hutton Institute. In this survey we don't collect names or other information that may directly identify you. However, we have to capture some demographics (age range, gender, level of education) which will help us produce summary statistics, but these will not be used in any attempt to reveal your identity. Furthermore, if you choose to share in open text entries any information that may directly or indirectly identify you, this information will be processed in line with data protection legislation and all reasonable steps will be taken to ensure confidentiality. No names or other identifying information would be included in any publications or presentations based on this questionnaire, and your responses will remain confidential.

The James Hutton Institute ('we', 'us', 'our') is the data controller with respect to how your participatory data will be used in this study. The James Hutton Institute will process the data for the purposes of the research outlined above. Research is a task that we perform in the public interest. Further information about how we process the data we collect as well as your rights with respect to your participation is available at our full privacy notice - https://www.hutton.ac.uk/terms. If you have any queries about your participation in this data collection, you can contact our Data Protection Officer on dpo@hutton.ac.uk.

CONTACT: For any inquiries, you can contact Dr Nazli Koseoglu at Nazli.Koseoglu@hutton.ac.uk.

ELECTRONIC CONSENT: Please select your choice below.

By clicking on the 'agree' button, you acknowledge that:
- You have read and understood the above information.
- You voluntarily agree to participate.
- You are 16 years of age or older.
If you do not wish to participate in the research study, please decline participation by clicking on the "disagree" button.
 agree
 disagree

Q1*[4]. Please select the code corresponding to your workplace from the drop-down list

…………………………………………………

Q2*. What sector is your company in?

…………………………………………………

Q3*. What is your position in the company? (Drop down menu of multiple choices relevant to the innovation)

…………………………………………………

Q4. What is your role in the organisation? [question adapted to the specific innovation: the format reported is the generic format used in the review of the Research Ethics Committee of the James Hutton Institute]

- ☐ Student placement/trainee
- ☐ Contract or temporary worker
- ☐ Permanent contact staff without managerial duties
- ☐ Sector or department manager
- ☐ Executive level manager
- ☐ Owner
- ☐ Other (please specify)

Q5. What is your responsibility in the innovation?
- ☐ I am the only person in charge of implementing the innovation
- ☐ I am one of the main people involved in the innovation
- ☐ I use or help with the innovation without a decision-making role
- ☐ I am distantly/ indirectly involved in the use or support of the innovation
- ☐ Other (please specify)

Q6. Have you been using this innovation since it was introduced in your company?
- ☐ Yes, I started using it since it was introduced in my company.
- ☐ No, when I started using it had already been introduced.

(This will only be asked to those who answered "yes" to the above question).

If you have started using the innovation after it had already been introduced, could you please specify how long you have been using it?

- ☐ I have been using the innovation less than 1 month
- ☐ I have been using the innovation for 1 to 3 months
- ☐ I have been using the innovation for 3 to 6 months
- ☐ I have been using the innovation for 6 months to 1 year
- ☐ I have been using the innovation for 1 to 2 years
- ☐ I have been using the innovation for more than 2 years

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[*]The questions 1-3 will not be asked in the link targeting the participants of the household food management innovation (T5.5). In question 4, they can be alternatively be asked about their role and responsibility in the household food management. The size and composition of the household will be already captured in the management survey by the academic partner in charge of this innovation.

Demographic Information

Q7. What is your age?
- ☐ 16 or 17
- ☐ 18-24
- ☐ 25-34
- ☐ 35-44
- ☐ 45-54
- ☐ 55-64
- ☐ 65 or more

Q8. What is your gender?
- ☐ Female
- ☐ Male
- ☐ Other (please state in your own words)
- ☐ Prefer not to say

Q9. What is your current level of education?
- ☐ No qualifications
- ☐ High school or equivalent qualification
- ☐ Trade/technical/vocational training
- ☐ University or college undergraduate degree
- ☐ Post graduate education (masters or PhD degree)

Q10 Which country are you based in? (To be included in the innovations with multiple country implementation and the multiple choice will be provided with relevant country options in the case of each innovation)

Q11. Please indicate how much you agree or disagree to the statements below.
(1- I strongly disagree, 5- I strongly agree)

Everyday huge quantities of food are wasted in the world.
Wasting food at home is inevitable.
It is impossible to avoid food waste at the workplace.
The problem of food waste worries me a lot.
Wasting food is irresponsible.
When I waste food, I feel guilty.
Wasting food does not go against my principles.
Everybody has a responsibility to reduce food waste.
I do not care if I waste food.
I am committed to reducing food waste in my household.
I am committed to reducing food waste in my workplace.
The daily amount of food waste is a serious problem for the planet.
Food waste is a major economic issue.
Wasting food is wasting other resources such as water and energy.
Avoiding food waste enables saving money.
Many people in our society do not care about their food waste.
My household supports my efforts to reduce food waste at home.
My colleagues support my efforts to reduce food waste at work.
I feel social/peer pressure to avoid wasting food.
I regularly throw away food that I could have consumed due to food spoiling
I seldom throw away food that could have been eaten because I have bought too much.
I sometimes throw away food that could have been eaten because I have prepared too much food.
I know what to do to reduce food waste at home.
I know what to do to reduce food waste when I eat out.
I know what to do to reduce food waste at work.
I know what to do to reduce food waste at restaurants/dining out.

I know how to recycle my food waste.

I have the ability to recycle my unavoidable food waste such as the inedible peels, pits and stones of fruits and vegetables, bones in meat and fish etc.

I have control over the amount of food waste produced in my workplace.

I have control over the amount of food waste produced in my household.

Reducing food waste in my household is a hassle.

Reducing my food waste requires a lot of time.

To reduce the food waste in my household I need to buy new equipment/new technology.

The local council provides satisfactory resources for recycling food waste.

My workplace provides satisfactory resources for recycling food waste.

Q12. Are you satisfied with this survey?

- ☐ Not at all satisfied
- ☐ Somewhat satisfied
- ☐ Neither satisfied nor dissatisfied
- ☐ Somewhat satisfied
- ☐ Very satisfied

Q13. If you have any additional comments, please write them:

Thank you for your participation!

Appendix 2 - Summary of innovations tested in the scope of the Lowinfood project.

Innovation	Description of the innovation	Survey recipients
2.1.RER	The institutional innovation developed by the region of Emilia-Romagna (RER) in Italy is an online platfrom to connect producers' organisations (Pos) with charities, ethanol producers and organises the donation of withdrawn fruits and vegetables.	Producer organisations and local municipalities
2.2 UNV	The organizational innovation establishes a network of fruit and vegetables producers, food processors and restaurants, promote cooperation agreements between them to reuse unharvested or surplus agricultural products	Primary producers, processors, food services
2.3 (4.2) Leroma	The digital marketplace facilitates the business to business exhange of surplus food materials	Companies that took part in the transactions
2.4. SLU retail sales forecasting	A machine learning algorithm based on store-specific historical dat forecasts sales of fresh produce in supermarkets.	Retailers' staff
3.2 CNA stakeholder innovayion	Innovative supplier/retailer interactions is social innovation which aims overcome issues affecting the quantity of bread wasted at retail stores and bakeries through collaboration among suppliers and retailers	Participants in the dialogue
3.3 FoodTrucks	A technical innovation to optimise order of bakery products to avoid unsold products at the end of the day	Bakery retailers' management
4.1 Stakeholder dialogue	The social innovation sets up dialogue among supply chain actors at different levels of the fish and seafood sector to reduce fish loss and waste.	Participants in the dialogue
5.1 Kitro	This technological innovation combines image processing and deep-learning technologies with a hardware solution to capture and analyse relevant information on the food being thrown away.	Participating restaurants and hotels staff
5.2 Mitakus	The forecasting software based on AI provides accurate forecasts and menu recommendations for commercial kitchens and restaurants that increasingly use fresh and perishable ingredients.	Participating restaurant kitchen staff
5.3 Matomatic	The technological innovation consists of a smart scale, giving primary school pupils feedback on how much plate waste they generate.	Pupils and canteen staff at participating schools
5.4 SLU/AIE Holistic education	The educational activities are carried out focused on raising the awareness of the food waste issue, to foster its reduction. Teaching materials about food waste will be adjusted be used during educational meals.	Pupil and teachers, kitchen staff in school canteens
5.5 Cozzo	The mobile app is combined with versatile shopping and meal planners, which helps household consumers avoid food waste by tracking what they have available at home and when it expires. This is the only household based innovation tested.	Members of participating households
5.6 Regusto	The moile app allows restaurants to sell fresh meals prepared in surplus and consumers to buy these meals at a reduced price as take-away	Staff of participating restaurants

Appendix 3 – Additional estimation results

Table 3.1. Statements which vary significantly between the baseline and post-implementation surveys for specific categories of respondents

Category	Construct	Statement	Baseline	Post-impl.	*p*-value
Employees	Attitude	economic	4.51	4.65	0.084*
		planet	4.55	4.70	0.052*
		waste_impos	2.72	3.04	0.954†
		waste_inevi	2.57	2.34	0.087*
	Intention	waste_hh	4.42	4.58	0.076*
		waste_work	4.27	4.61	0.003***
	Moral concern	guilty	4.22	4.38	0.100*
		waste_irres	4.27	4.56	0.015**
	PBC	know_eatout	4.02	4.23	0.094*
	Situational factors	waste_time	4.07	3.84	0.910†
	Subjective norm	colleagues	4.02	4.24	0.051*
Households	Attitude	economic	4.35	4.57	0.081*
		resources	4.73	4.95	0.013**
		waste_impos	2.59	2.20	0.038*
		waste_quan	4.70	4.89	0.038**
	Behaviour	food_spoil	3.25	3.74	0.007***
		prepare_waste	3.75	4.05	0.155‡
	Intention	not_care	4.65	4.86	0.039**
		waste_hh	4.20	4.54	0.011**
	Moral concern	guilty	4.43	4.61	0.097*
		waste_irres	4.23	4.58	0.007***
		worry	3.76	4.14	0.014**
	PBC	control_wp	3.02	2.44	0.987†
		know_hh	4.08	4.40	0.027**
		know_restaur	3.82	4.11	0.096*
		recycle	2.60	3.04	0.067*
Students	Attitude	economic	4.04	3.72	0.982†
	Behaviour	prepare_waste	3.56	3.23	0.060*‡
	Intention	not_care	4.31	4.02	0.976†
		waste_hh	3.71	3.44	0.968†
		waste_work	3.57	3.37	0.938†
	Moral concern	guilty	3.71	3.50	0.911†
		principle	3.18	2.84	0.014**
	PBC	recycle	3.40	3.17	0.913†
Female	Attitude	waste_inevi	2.67	2.42	0.020**
	Behaviour	food_spoil	3.30	3.58	0.014**
	Moral concern	principle	2.53	2.19	0.014**
		waste_irres	4.07	4.25	0.064*
	PBC	control_hh	3.90	4.07	0.051*
		control_wp	3.22	2.86	0.995†
		know_hh	4.16	4.32	0.054*
Male	Attitude	economic	4.15	4.37	0.075*

		planet	4.18	4.47	0.026**
		waste_quan	4.23	4.63	0.010**
	Behaviour	prepare_waste	3.75	3.40	0.047**‡
	Intention	waste_work	3.73	3.97	0.094*
	Moral concern	responsible	4.11	4.40	0.040**
		worry	3.67	4.03	0.021**
Young age	Attitude	economic	4.16	3.99	0.909†
		waste_impos	2.61	2.39	0.052*
		waste_inevi	2.59	2.43	0.091*
	Behaviour	food_spoil	3.25	3.48	0.051*
	Moral concern	principle	2.80	2.47	0.012**
	PBC	control_wp	3.16	2.8	0.995†
	Subjective norm	pressure	3.01	2.81	0.933†
Old age	Attitude	economic	4.51	4.67	0.048**
		waste_impos	2.69	2.99	0.950†
	Behaviour	food_spoil	3.43	3.67	0.079*
		rarely_waste	3.57	3.82	0.072*
	Moral concern	waste_irres	4.35	4.55	0.048**
	Situational factors	hassle_hh	3.97	3.67	0.976†
		waste_time	4.01	3.77	0.928†
	Subjective norm	pressure	2.81	3.06	0.062*
Low education	Behaviour	prepare_waste	3.66	3.37	0.030**‡
	Moral concern	principle	2.67	2.47	0.082*
	Situational factors	waste_time	3.55	3.38	0.903†
High education	Attitude	economic	4.36	4.57	0.053*
		waste_quan	4.44	4.76	0.007***
	Behaviour	food_spoil	3.30	3.66	0.015**
		prepare_waste	3.61	3.93	0.078*‡
		rarely_waste	3.50	3.91	0.015**
	Intention	waste_hh	4.33	4.58	0.015**
	Moral concern	waste_irres	4.22	4.53	0.007***
		worry	3.86	4.13	0.037**
	PBC	control_wp	3.05	2.69	0.953†

Notes: The *p*-values refer to monodirectional *t*-tests, whose direction is based on the hypotheses in Table 3, apart from those marked with ‡, which refer to bidirectional *t*-tests. Significance levels: *** 0.01, ** 0.05, * 0.10. † Significant change in the opposite direction.