

Stakeholder perceptions on the potential of actions to reduce food loss and food waste

ABSTRACT: In Flanders in 2020, 883 742 tonnes of food were lost or wasted this corresponds with 14% of the produced food. This is not an isolated case, all over the world food is going lost or wasted. While at the same time over 800 million people are suffering from hunger. Furthermore, food loss and food waste have an enormous environmental impact. Although the problem is well known, and in addition there is a desire to do a lot about food loss and waste, on a societal, political, and academic level, tangible actions are still lacking. Since all actors in the food supply chain must lower their food loss and waste, it is very important to have insight into the actions they perceive as the most powerful. In this research, a Q-study is conducted by stakeholders throughout the whole food supply chain. To answer the research question “*What actions to reduce food loss and food waste along the food supply chain, will have the greatest potential according to stakeholders?*” The participants ranked 63 statements about possible actions to lower food loss and waste, collected via literature review and interviews. These statements were cross classified in seven stages of the food supply chain, by three types of measures.

The findings show 3 different factors or viewpoints. These points of view will prefer other combinations of actions, it is for example clear that one perspective prefers technical measures, whereas the other perspectives see more potential in societal action, combined with institutional and technological ones. It also become clear which stakeholders have the greatest burden to take actions, the first perspective puts the greatest burden on the consumers and the distribution and logics. According to the second perspective, most effort must be demanded from the households and the food service. While the last perspective thinks that the full food supply chain has to change. Due to interviews conducted at the same time as the Q-sorts, the found perspectives are interpretable.

KEYWORDS: food loss, food waste, Q-method, stakeholders' perception, circular economy

1. INTRODUCTION

Globally, approximately 13% of all produced food is lost during harvest, transport, storage, and processing, which is known as food loss. An additional 17% is wasted at the retail, food service, and consumer level, which is known as food waste (United Nations, 2022). Some scholars consider food loss and waste (FLW) as an inevitable step in the increasingly complex food supply chain (see for example: Aschemann-Witzel et al., 2015; Canali et al., 2014; Revilla and Salet, 2018). In addition, not only is the food itself lost or wasted, but also the water, energy, edible land, and labour that were used for its production (Gille, 2012; Porpino, 2016). Moreover, food is a resource intended to meet the basic human need of nutrition (Gille, 2012).

Although, the problem is well known and there is a desire to increase efforts to reduce food loss and waste (van der Werf et al., 2021), tangible action is lacking at the political level (Van Geffen et al., 2017), while social causes have received less attention in research (Gille, 2012). Porpino (2016) found a similar conclusion, indicating that most research on food loss and waste is published in journals focusing on waste or food, which may result in insufficient attention to the marketing and behavioural economic perspective. Therefore, he suggests that there is a need for more mixed method research in the field of food loss and waste.

Flanders (the northern part of Belgium, and the location of this study) aims to reduce food loss and waste by 30% by 2025 compared to 2015 through prevention, reprocessing and high-value valorisation (Braekevelt et al., 2021, p. 38). To achieve this reduction, specific actions need to be taken by all actors in the food chain (Braekevelt et al., 2023). It is therefore important to find out stakeholders' perspectives to understand which actions they perceive as having the highest potential effect and which stages in the food supply chain need to take the largest effort. The Q-method is used to identify different perspectives, each perspective will prioritise solutions to solve the problem of food loss and food waste. The Q-method provides a structured approach that facilitates the expression of individual, subjective viewpoints about

market-relevant discourses (Mandolesi et al., 2022; Watts & Stenner, 2012). Q is used in different research fields (Dziopa & Aher, 2011; Mandolesi et al., 2021), that way, it knew a particular growth in environmental, social and health research in recent decades (Sneegas et al., 2021; Zabala & Pascual, 2016).

In the following chapter, we first discuss the definition of food loss and waste as well as the scope and current state of affairs. The third part of this paper discusses the theoretical framework of the Q-method. Part four and five review and discuss the results of the Q-method, respectively, followed by concluding remarks.

2. BACKGROUND

2.1. Definition, terminology and scope

When comparing the Flemish definition (Braekevelt et al., 2023, p. 15) with the European definition (art. 1, 3), c, Directive 2018/851), the difference in terminology is immediately noticeable. The European Union uses *food waste* to refer to both, edible and non-edible FLW along the food supply chain (The European Commission Joint Research Centre, 2020). In Flanders, the word *food loss* (i.e. *voedselverlies*) is used, to refer to all losses and waste of edible-food (Rekenhof, 2021) while the word *side stream* (i.e. *nevenstromen*) is used to refer to non-edible parts (Braekevelt et al., 2023, p. 15). In contrast, the UN makes a distinction between *food loss* and *food waste*, the former refers to losses in the first stages of the food supply chain, whereas the latter is about waste generated at retail, food service and households (United Nations, 2022).

This difference inevitable causes a difference in system boundaries on multiple points. First, the point from which something is called “*food*” – and thus the point from which one starts counting FLW – differs, in Flanders it is from the moment crops are ready for harvest or animals are ready for slaughter (Braekevelt et al., 2023, p. 17). While, according to European legislation (art. 2, c., Regulation 178/2002), food waste can only occur after harvest. A second difference point, inedible parts are excluded from the Flemish definition, but those inedible parts are included in the European definition if they *were not separated from the edible parts when the food was produced* e.g. bones, peels, leaves (point 2, Delegated Decision 2019/1597). A third aspect of divergence, food loss is strictly defined in Flanders as: *resources or products destined for human consumption that are not eaten by humans*. This indicates a loss of food for human consumption. However, this waste stream can still be highly valorised such as animal feed, material and/or energy applications (Braekevelt et al., 2023, p. 15). By contrast, food that is been wasted in a production process and that will be reused, is excluded from the European definition of food waste, since it is seen as a *by-product* (art. 5, Directive 2008/98/EC). This means that animal reuse for example does not count as FLW. In this paper the Flemish definition is used.

2.2. Current situation and regulation

One of the Sustainable Development Goals (SDG 12.3) set by the United Nations (s.d.) is: *to halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses, by 2030*. The European Union fleshed out this SDG in the Waste Directive 2018/851 (point 31), stating that member states should aim to reduce food waste across the food supply chain by 30% by 2025 and 50% by 2030. However, these European targets are not yet legally binding (The European Commission Joint Research Centre, 2020). Binding targets will be proposed based on data provided by the member states; currently (January 2024), a 10% reduction is proposed for the food processing industry and 30% for retail, food service and households (European Commission, sd.).

Flanders has translated the European objective into two consecutive initiatives: the *Food Loss Chain Roadmap 2015-2020* and the *Action Plan for Food Loss and Biomass (Residual) Flows Circular 2021-2025*. These policy documents state that food loss had to be reduced by 15% by 2020 compared to 2015, and by 30% by 2025 in order to meet SDG 12.3 by 2030 (this can be seen as a reduction of 50% by 2030 – Braekevelt et al., 2021; Rekenhof, 2021). Again, these targets are not binding, as the Flemish

government has opted for a commitment to effort rather than results. Although, the *Food Loss Chain Roadmap 2015-2020* initially included 57 actions and evolved to 97 actions, only five of those were quantified (Rekenhof, 2021). The same applies to the *2021-2025 Action Plan*, in which most actions are qualitative. Furthermore, there is a contradiction in the Flemish policy documents: *Vizier 2030* (i.e. translation of the SDG by the Flemish government – Rekenhof, 2021) mentions a reduction of only 30% by 2030 compared to 2015, whereas the *Flemish coalition agreement 2019-2024* aims at a 50% reduction in food loss by 2030.

In 2016, the European FUSIONS¹ project released a manual (Tostivint et al., 2016) that allows all member states to determine food loss and food waste in the same way, making comparison possible (Rekenhof, 2021). Three years later, the method was modified and made official by the European Parliament and Council in *a common methodology and minimum quality requirements for the uniform measurement of levels of food waste* (Delegated Decision (EU) 2019/1597). Flanders used the method as described by Tostivint et al. (2016) for its baseline measurement, carried out in 2017 (Rekenhof, 2021). It showed that in 2015, around 907 000 tonnes of food were lost or wasted in the total Flemish food supply chain (Criel & Fleurbaey, 2019, p. 7). However, according to the 2020 follow-up (which used the modified method – Rekenhof, 2021), an estimated 883 742 tonnes of food were lost or wasted (Braekevelt et al., 2023, p. 11), which is barely 2.6% less than the food loss in 2015. Even when taking into account the slightly modified method, the first target of minus 15% food loss, is far from being met.

This means that the Flemish food supply chain operates sub-optimally as well as the food supply chain in the rest of the world (FAO, 2013). In Flanders, about 14% (883 742 tonnes) of food production, was lost in 2020 (Braekevelt et al., 2023). Less than two per cent (16 979 tonnes) of this, got a human reuse through donation to social organisations (Braekevelt et al., 2023). Although each stage contributes to the food loss and waste problem, this contribution is not equal. Primary producers (39.5%), food industry (25.9%) and consumers (25.3%) are the largest contributors for Flanders (Braekevelt et al., 2023).

Until now, we only talked about the Flemish government, but there is also the Belgian Federal government which has less influence on the topic of food loss and waste. However, two important changes were made on the federal level. In 2013, they eliminated VAT on donated food, i.e. businesses can now reclaim VAT on both discarded and donated food (Rekenhof, 2021). Ideally, this will disappear for the former. A second change is the relaxation of some (strict) requirements on food donation (Rekenhof, 2021).

2.3. Previous research

A food system comprises a multitude of actors, which are interdependent (Röös et al., 2023). Food loss and waste is therefore the result of a complex pattern of highly diverse but interconnected causes. This makes it impossible to identify a single cause or solution (Aschemann-Witzel et al., 2015; Canali et al., 2014). A good example of this are the European aesthetic standards for fresh intended for consumers fruit and vegetables (investigated by Gellynck et al., 2017 for Flanders). These were implemented to protect the European consumers and producers in the expanding international economy. The European Union weakened its cosmetic standards for fruit and vegetables. Since 2008², there are specific standards for only ten (instead of 36) types of fruit and vegetables (Regulation (EU) No 543/2011, Annex I, Part B). The 26 products for which there are no longer specific rules on shape, size and colour have since been covered by a general marketing standard (Regulation (EU) No 543/2011, Annex I, Part A). However, this new regulation did not lead to much change, because the simplification does not include the most consumed products. Moreover, the industry and retailers continued to use the old standards as private norms and made some of them even stricter. The industry uses the argument that processing, storing, and distributing products with regular shapes and sizes is easier; and that the system is adjusted to this. According to the retail, these standards are maintained because consumers expect this aesthetics. But an experiment of the European commission (2015) showed that informing consumers (with an "authenticity" or "anti-food waste" label) or by reducing the price will result in approximately 40% of the consumers that are willing to buy imperfect fruit or vegetables. When both are combined, even half

¹ FUSIONS: Food Use for Social Innovation by Optimising Waste Prevention Strategies

² Due to Regulation (EC) No 1221/2008 which was replaced by Regulation (EU) No 543/2011

of the consumers are willing to buy imperfect fruit or vegetables. Auctions and other actors further down the food supply chain argue that food loss through these cosmetic standards is limited. But, according to farmers this is not true, other actors do not see the dropouts and losses because farmers already estimate the quality before taking it to the auction; to prevent an overload of the market (Gellynck et al., 2017; Richards et al., 2021). In this case it is not easy to attribute the losses to one actor or come up with one solution.

However, this research needs a comprehensive list of solutions to tackle the food loss and waste problem. A study by Canali et al. (2014 – part of the FUSIONS project) helped us with this. They reviewed the literature and conducted expert surveys, to distinguish almost three hundred causes of FLW along the food supply chain and as many future threats of increase and opportunities of reduction. They sorted the causes, threats, and opportunities along the food supply chain. This made them the first to analyse the entire food supply chain in such a comprehensive way. In addition, they explored how technological development, better management of the food supply chain and changing consumers' behaviour and lifestyle can influence food loss and waste, referred to as '*the three context categories*'. Their output is structured in a cross classification: every row represents a stage in the food chain and every column describes one of the three context categories. This structure proposed by Canali and colleagues helped us to structure the statements we extracted from literature. We replaced one of the seven stages proposed by Canali et al. (2014) by "Whole food chain" to make clear that some solutions (and problems) cannot be allocated to a single stage.

Furthermore, over the years, scholars' attention has shifted from food loss to food waste (Southerton & Yates, 2015). There are a bunch of articles that focus on consumers, they describe how marketing strategies (such as pack size, data labels, package design) and retail decisions (e.g. pricing strategies) contribute to overconsumption and consequently food waste (Aschemann-Witzel et al, 2016); that consumers are more picky in the supermarket than at home when it comes to aesthetic standards, expiry dates and damaged packaging (De Hooge et al., 2017); and that consumers' motivation, skills and knowledge regarding food, as well as the priority they give to food waste are important to reduce it (Aschemann-Witzel et al., 2015). Porpino (2016) and Rohm et al. (2017) also point to consumers – and sometimes the retail and food service – as the main contributors to the FLW problem. Only limited research examined other actors in the food chain, Mesiranta et al (2022) claim that food waste is currently too often blamed on consumers. They, in contrast, framed the problem of food waste in various ways, with different actors causing food loss and waste in each case. Another perspective on food loss and waste is described by Gille (2012), it is seen as a consequence of actions taken by different actors in the food chain, to protect themselves from uncertainties, and this is done in every stage from farmer to consumer.

In addition, Q-studies related to food loss and food waste are scarce. There is a study, conducted by Revilla and Salet (2018) in which they examine the relation between household food rituals and food waste. Apart from this paper, we are not aware of any other Q-study focusing on food loss or waste. Although there are some studies with a broader scope such as environmental sustainability (Venneman et al., 2020), desirable food system futures (Belisle-Toler et al., 2021), food system sustainability (Röös et al., 2023), or the performance of college foodservices (Miroso et al., 2016), which encompass one or a few items on food loss or waste.

3. METHODOLOGY

A Q-study is a mixed method (Sneegas et al., 2021), which combines the strength of both qualitative and quantitative approaches (Dziopa & Aher, 2011; Zabala & Pascual, 2016). Q-studies are more structured and thus more efficient compared to other qualitative research (Mandolesi et al., 2021). In contrast to quantitative research, it requires respondents to consider all the aspects at the same time and give their own interpretation of the statements (Mandolesi et al., 2021). Q consists of (a combination of) the following nine components: defining the aim of the research, formulating the research question, collecting the discourse, drafting the Q-set, assembling P-set, performing Q-sort, conducting semi-structured interviews, performing a factor analysis and interpreting the identified factors.

3.1. Defining the Aim and the Research Question

The aim of this study is finding actions that can reduce food loss and waste, and besides can be expected to have the most support from stakeholders. In addition, it will become clear which type of actions (technical, institutional, or societal) are most preferable and which actors in the food supply chain need to take the greatest effort, according to the different perspectives. The research question used for this purpose is: “*What actions to reduce food loss and food waste along the food supply chain, will have the greatest potential according to stakeholders?*”. It is common to a Q-study that, the research question is similar to the question presented to the respondents (Watts & Stenner, 2005). This requires the question to be simple, clear, concise, and straightforward. Furthermore, it is appropriate for the question to contain only a single proposition (Watts & Stenner, 2012). Therefore, the question presented to the respondents is: “*Which actions can according to you reduce the food loss and food waste the most? Please sort the provided statements in such a way that they best reflect your point of view.*”

3.2. Concourse and Q-set

First, a large number of items must be collected (called the concourse) (Dziopa & Aher, 2011), which is then reduced to a manageable amount (i.e. the Q-set) through reviews and piloting. This excessive selection and reduction process is necessary to not exclude relevant items too early in the process, find the adequate wording, control for duplicates, and even come up with new items (Watts & Stenner, 2012). The concourse in this research consists of over 400 statements, collected via a literature review of scientific papers, governmental research papers, policy documents and Flemish newspaper articles. To move to the final Q-set, interviews with six stakeholders and a discussion among the researchers were used. During these, it became clear which statements and wording were preferred, besides some new statements and ideas were added. Afterwards, some people were asked to carry out a pilot, based on this some minor adjustments were made.

Moreover, a structured Q-set was used, meaning that the subject is divided into sub-sections that are each given an equal share in the Q-set (Watts & Stenner, 2012). We opted for a matrix similar to the one defined by Canali et al. (2014) to structure the statements. The grid consists of seven stages in the food supply chain (rows in table 1) and three types of measures (columns in table 1). Our Q-set consists of 63 statements, so every field in the grid contain three items. A rule of thumb is that the final Q-set should consist of 40 up to 80 items (Watts & Stenner, 2012). Fewer items threaten the condition of a balanced Q-set (i.e. represents the various prevailing concourses). While more items create too much cognitive burden for participants (D'Amato et al., 2019; Watts & Stenner, 2012), take up too much time (Dziopa & Aher, 2011) and makes the analysis harder (Minkman & Molenveld, 2020). The 63 retained items are derived from: Aschemann-Witzel et al. (2015; 2016), Bolton and Reczek (2022), Canali et al. (2014), Gellynck et al. (2017), Gille (2012), Gustavsson et al. (2011), MacArthur (2023), Mandolesi et al. (2021), Mesiranta et al. (2022), Porpino (2016), Revilla & Salet (2018), Rohm et al. (2017), and three documents published by the Flemish government or governmental institutions (Vision 2050, Action plan food loss 2021-2025, and business plan department of agriculture and fishery 2020/24).

Lastly, we tried to lower the cognitive burden for the participants, by starting every statement with the same prefix (*to reduce FLW, ...*) (Watts & Stenner, 2012), avoiding technical or complicated terminology as much as possible (Watts & Stenner, 2012), and eliminating items that contain two propositions or that are negatively expressed (Watts & Stenner, 2012). Subsequently, it is not intended that the items are unambiguously worded, there should be room for interpretation by the respondents (Stenner & Capdevila, 2019; Watts & Stenner, 2012).

Table 1. Matrix with the used structure and the Q-set.

	Technical measures	Institutional measures	Societal measures
Primary producers	<p>To reduce FLW, there is a need to produce alternative proteins.</p> <p>To reduce FLW, more genetically modified products should be grown or cultivated.</p> <p>To reduce FLW, less food should be produced.</p>	<p>To reduce FLW, it should be mandatory that all food is harvested.</p> <p>To reduce FLW, subsidies for agriculture should be calculated differently.</p> <p>To reduce FLW, crops for human consumption should only be consumed by humans.</p>	<p>To reduce FLW, there is a need for urban agriculture.</p> <p>To reduce FLW, farmers should have more influence on the price for their produce.</p> <p>To reduce FLW, people would be willing to take the remaining food from the fields after harvest (i.e. gleaning).</p>
Processing	<p>To reduce FLW, product packaging should be done more carefully.</p> <p>To reduce FLW, persons involved in food processing should be better trained.</p> <p>To reduce FLW, more research should be done on alternate processing for edible residues in food processing plants.</p>	<p>To reduce FLW, there should be no more food advertising campaigns.</p> <p>To reduce FLW, there should be rules about standardising packaging.</p> <p>To reduce FLW, food processing plants should be equipped with the best available technology.</p>	<p>To reduce FLW, more fresh products should be frozen.</p> <p>To reduce FLW, there should be fewer varieties and brands of one product.</p> <p>To reduce FLW, different sizes of packaging should be available.</p>
Distribution and	<p>To reduce FLW, more research should be done on extending the shelf life of food.</p> <p>To reduce FLW, logistics and distribution systems should become smarter.</p> <p>To reduce FLW, food hubs are needed (i.e. places where surplus food is gathered, sorted, distributed, or processed and marketed for human consumption).</p>	<p>To reduce FLW, a levy should be imposed on food imports.</p> <p>To reduce FLW, products should have a label indicating food miles.</p> <p>To reduce FLW, products should include a better description about the ideal storage place and method.</p>	<p>To reduce FLW, packaging should be functional rather than aesthetic.</p> <p>To reduce FLW, more seasonal and local food should be consumed.</p> <p>To reduce FLW, more food should be ordered on demand.</p>
Retail	<p>To reduce FLW, more use should be made of quick sales.</p> <p>To reduce FLW, better estimates of expected retailer sales should be made.</p> <p>To reduce FLW, longer shelf-life products should not be placed on shelves until previously expired products have been sold.</p>	<p>To reduce FLW, food discounts should not be allowed.</p> <p>To reduce FLW, more products should be sold without expiry dates.</p> <p>To reduce FLW, shops should still offer products that exceed the "best before" date.</p>	<p>To reduce FLW, there should be more local stores.</p> <p>To reduce FLW, more meal boxes should be ordered and prepared.</p> <p>To reduce FLW, shops should reduce their offerings.</p>
Food service	<p>To reduce FLW, restaurants should serve less per serving.</p> <p>To reduce FLW, catering establishments should prepare less food.</p> <p>To reduce FLW, better estimates should be made of expected sales at restaurants.</p>	<p>To reduce FLW, different sizes of dishes should be available.</p> <p>To reduce FLW, menu choices should be limited.</p> <p>To reduce FLW, restaurants should be labelled according to the amount of food they have thrown away in the past year.</p>	<p>To reduce FLW, restaurants should offer doggy bags as standard.</p> <p>To reduce FLW, ready-to-eat meals and fast food should disappear.</p> <p>To reduce FLW, catering staff should ask if nuts, bread, etc. are wanted, before this is served.</p>
Households	<p>To reduce FLW, better knowledge of the "best before" and "use by" is needed.</p> <p>To reduce FLW, consumers should process leftovers more often.</p> <p>To reduce FLW, consumers should use new tools such as smart fridges and apps that track the shelf life of products.</p>	<p>To reduce FLW, food waste collection should become more expensive.</p> <p>To reduce FLW, consumers should plan their purchases better.</p> <p>To reduce FLW, the diet of consumers should change.</p>	<p>To reduce FLW, consumers should eat more healthy food.</p> <p>To reduce FLW, consumers should be less picky.</p> <p>To reduce FLW, we should get rid of the idea that a lot of food should always be offered (e.g. at parties).</p>

Whole food chain	To reduce FLW, a measurement network that maps all food flows is needed.	To reduce FLW, food safety rules should become less stringent.	To reduce FLW, aesthetic standards for food should disappear.
	To reduce FLW, food should be handled more carefully.	To reduce FLW, the government should use financial incentives (taxes and subsidies).	To reduce FLW, all actors in the food chain should cooperate better.
	To reduce FLW, surpluses should reach food aid organisations more often.	To reduce FLW, products should be labelled to reflect how much food was lost to reach the final product.	To reduce FLW, more awareness must be created about the consequences of food waste.

3.3. P-set

Next, the P-set – the group of participants – was very carefully and well considered selected, so all potentially relevant perspectives are represented (Mandolesi et al., 2022; Minkman & Molenveld, 2020). This means that random selection of the participants is to be avoided (Mandolesi et al., 2021; Watts & Stenner, 2012). So, the selection of the P-set was partially done via purposive sampling (i.e. based on the knowledge of the researchers of stakeholders and organisations in the food supply chain) and enhanced with snowball-sampling. Q-studies aim to establish the existence of points of view rather than generalize the results to the population. This allows the sample to remain small, the rule of thumb for this is: the Q-set must contain twice as many items as there are participants in the P-set (Watts & Stenner, 2012). Thirty-one interviews were conducted, unfortunately, two interviews had to be removed³, which results in a P-set of twenty-nine stakeholders. Figure 1 gives an impression of the knowledge field of the stakeholders.

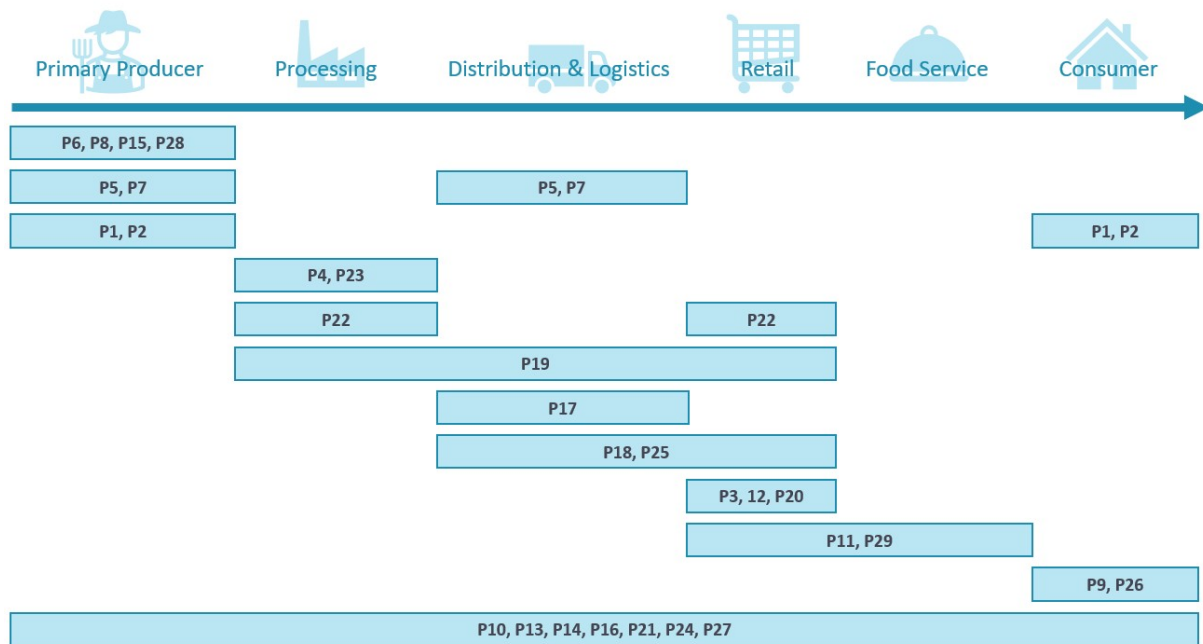


Figure 1. Composition of the P-set

³

One respondent refused to conduct the Q-sort. Another respondent had some technical difficulties, because of that the interview was done in two sessions with three weeks in between, during the second part the respondent contracted themselves multiple times compared to the first interview.

3.4. Q-sort

After defining the Q-set and P-set, the data collection could start. All the items of the Q-set were sorted by the participants in a grid with a quasi-normal distribution along a single, face-valid dimension (fig. 2). A thirteen-point scale (i.e. -6 to +6) is advised when the Q-set exceeds 60 items (Watts and Stenner, 2012), the scale was labelled from ‘most disagree’ to ‘most agree’. There are as many cells in the grid as items in the Q-set (i.e. 63), meaning that the respondents are forced to allocate a predefined number of items to every ranking value (Watts & Stenner, 2012). Respondents could rank a limited number of items at the tails, i.e. relative strong feeling. A larger number of statements could be ranked in the centre of the distribution at a rather neutral score, i.e. relative indifferent (D’Amato et al., 2019; Watts & Stenner, 2012).

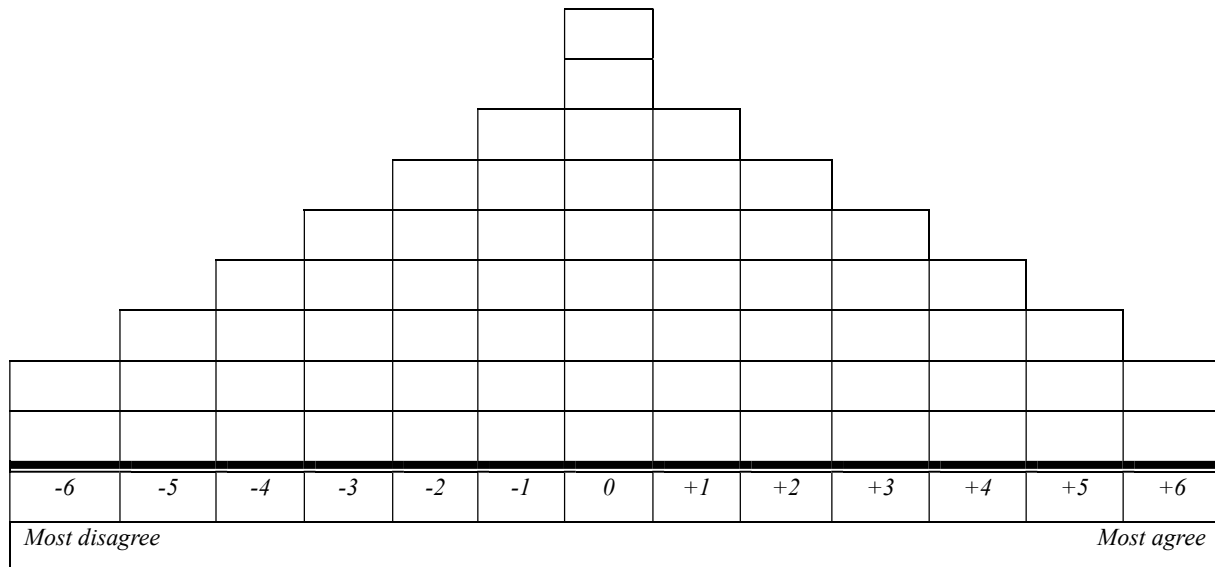


Figure 2. Example of the used Q-sort grid

More specific, the data collection was done online with *Q-sortware* (Pruneddu, sd.), a researcher was online available during the entire sorting process. This maximises the benefits of both, online and in-person Q-sorts, as described by Minkman and Molenveld (2020). For instance, online data collection increases the efficiency for the researchers. In addition, it gives the participants the benefit of working on their own – to enhance this, we suggested that participants could turn off their camera and/or microphone. On the other hand, the advantages of an in-person Q-sort are present: respondents did not need to hesitate to ask questions and, the researcher was able to correct the participants if necessary. This is recommended by Watts & Stenner (2012) because Q, compared to other data collection methods, results more often in non-response and incorrect sorts when is opted for a self-administered mode of data collection. Besides, most of the Q-sorts were conducted in Dutch⁴, because this is the native language of the participants.

To lower the cognitive burden for the participants, a step-by-step approach was proposed to the P-set, however they were free to deviate. Firstly, participants were asked to sort the items in five groups (those with which they most agree, agree, most disagree, disagree, and feel neutral about – Mandolesi et al., 2022; Watts & Stenner, 2012). There were no restrictions on the number of items that could be added to one of the five groups (Watts & Stenner, 2012). Furthermore, this pre-sorting was not prescriptive, so deviations and shifts might happen during the next step (Mandolesi et al., 2022). Those two remarks were mentioned to the participants before starting the pre-sorting task. Secondly, the participants are asked to place the items in the quasi-normal distribution, based on the pre-sorting. The best way to sort the statements is to first pick the two items the respondent feels the most positive (resp. negative) about and moving gradually to the centre of the distribution (Watts & Stenner, 2012). Thus, first the ‘most agree’, afterwards the ‘agree’, followed by the ‘most disagree’ and ‘disagree’ and finally the ‘neutral’

⁴ With the exemption of two English interviews and two mixed French/Dutch interviews.

column will be placed in the grid. Lastly, the participants are asked to revise their sorting task and, if necessary, make changes.

3.5. *Interview*

During the interview, some questions about the company/organisation and the function of the respondent were asked. Furthermore, information related to the topic which could influence the participants point of view was asked, examples of these are: positioning of the company in the food supply chain, definition of FLW, perception of the food loss and waste problem. But the most important questions target the reason for the participant's sort and the interpretation of the sorted items, with a focus on the five 'most agree' and five 'most disagree' statements (D'Amato et al., 2019; Mandolesi et al., 2022). For completeness, it is also asked whether there are other items respondents want to discuss or whether any item was missing. If the latter is the case, they are asked to formulate their own statement and rank it in the quasi-normal distribution (Watts & Stenner, 2012). Finally, it is asked if participants know other relevant people in the food supply chain, which can conduct the Q (i.e. snowball sampling). The full interview guideline can be found in Appendix A. The interview, including Q-sort, took between 50 and 120 minutes.

3.6. *Factor Analysis and Interpretation*

The factor analysis used to analyse the Q-sorts is often called an inversed or by-person factor analysis. In a 'traditional R-method' factor analysis, the researcher tries to identify correlations between variables across a sample of individuals. In the case of an inversed factor analysis, the researcher tries to discover correlations between a sample of individuals (P-set) across variables (Q-set) (Mandolesi et al., 2022, p. 567). Respondents with similar Q-sorts are placed, through statistical analysis, in one group (i.e. a factor, perspective or viewpoint), within these perspectives we find similarities between the participants across the sample of statements (D'Amato et al., 2019, p. 465). The number of factors (sometimes called 'F-set' – Stenner & Capdevila, 2019) that are extracted, is mainly dictated by the collected data. However, there are some criteria that can help in this (see appendix B).

The analysis of the Q-sorts was conducted with Stata. First a correlation matrix, of the different Q-sorts was produced, this provides inside in the degree of similarity of different Q-sorts. Next the `qfactor` command, as described by Akhtar-Danesh (2018), was used; it is the first Stata-command to analyse Q-sorts, however it is not yet widely used. The command was further adjusted to the dataset by selecting the optimal number of factors and choosing a well fitted extraction and rotation method. Rotation results in an increase in the loading on a factor for a specific Q-sort and in a decrease in the loading on all other factors for that specific Q-sort (Watts & Stenner, 2012), which makes a rotated factor more interpretable (Akhtar-Danesh, 2018).

```
qfactor varlist [if] [in], nfactor(#) [extraction(string) rotation(string)
      transpose(string) statement(string) score(string) esize(string)
      bipolar(string)]
```

Afterwards, factor scores (i.e. z-scores) were estimated for every statement of every perspective (Akhtar-Danesh, 2018). They are based on the weighted averages of all Q-sorts that significantly load on a factor (Mandolesi et al., 2022; Watts & Stenner, 2012). For an easier interpretation, the factor scores were converted into factor arrays (Watts & Stenner, 2012). This can be seen as the Q-sort that best fit an identified perspective and is represented in a Q-grid or in a table. Thereafter, significant differences and similarities between factors could be estimated (Akhtar-Danesh, 2018).

Lastly, the identified factors were interpreted. Every perspective has its own narrative, which is logic and supported by the information of the interviews, the factor-arrays, statements with high/low scores and, distinguishing and consensus statements (Watts & Stenner, 2012).

4. RESULTS – FACTOR ANALYSIS

In the literature, we found nine criteria that helped us to determine the number of factors, however the number of optimal factors varied due to the variety of setting of the `qfactor` command. In appendix B the full tables with comparison between the different outcomes can be consulted. Here the reasoning will briefly be discussed.

Most Q-analysis find between three and seven factors (Dziopa & Aher, 2011), so we tested this in Stata. First the extraction methods were compared based on the criteria that (1) the Eigenvalue must be greater than one, (2) every factor must explain at least 5% of the variance, (3) the cumulative variance must be at least 50%, and (4) on every factor at least two significant Q-sorts must be loaded. The principal component analysis was chosen since this was, taking the above criteria into account, the only extraction method that was able to extract three factors (appendix B, table B1).

Second, the rotation method was chosen based on the number of confounding and insignificant Q-sorts, and the number of participants that were allocated to every factor. The Quartimax and Oblimin rotations distributed the respondents uneven over the perspectives (i.e. 17 participants vs. 1 participant). Whereas the Promax rotation has a more equal distribution, however six of the Q-sorts could not be loaded on a factor due to insignificance or confusion. That leaves only varimax and equamax rotation, between which the difference is very limited. When using varimax rotation participant 8 is not loaded, whereas P8 is loaded on factor 3 when making use of equamax rotation. Similarly, participant 21 is not loaded when making use of equamax, while P21 is loaded on factor 2 when using varimax rotation. Taking into account the criteria of ‘logic interpretation of the factors’ we opted for varimax rotation.

Third the calculation method of the factor scores was examined. Brown scores created significant correlations between the different factors which is not preferred. The other three methods have similar low correlations, because of that the criteria of ‘logic interpretation of the factors’ was again used, which resulted in Thompson score.

Last the effect size was set to 1, as argued by Akhtar-Danesh (2018) a larger effect size will result in less distinguishing statements and more consensus statements. Which is wanted since positive consensus statement are entry points for change.

Table 2 presents the factor arrays for the three discovered perspectives. While table 3 summarize the perspectives.

Table 2. Factor arrays of the three identified perspectives.
Increasing strength of (dis)agreement is shown by darker shades, where green is used for agree and red for disagree.

No.	Statement	Perspective		
		1	2	3
	<i>To reduce FLW, ...</i>			
1	... catering staff should ask if nuts, bread, etc. are wanted, before this is served.	0	5	-2
2	... restaurants should serve less per serving.	-1	2	-4
3	... more use should be made of quick sales.	0	2	2
4	... restaurants should offer doggy bags by default.	0	4	3
5	... better knowledge of the "best before" and "use by" is needed.	5	5	3
6	... a measurement network that maps all food flows is needed.	6	-2	4
7	... there is a need to produce alternative proteins.	0	-4	-3
8	... there is a need for urban agriculture.	-2	-6	2
9	... the government should use financial incentives (taxes and subsidies).	-6	3	6
10	... more awareness must be created about the consequences of food waste.	2	6	4
11	... product packaging should be done more carefully.	4	0	-5
12	... packaging should be functional rather than aesthetic.	2	0	0
13	... we should get rid of the idea that a lot of food should always be offered (e.g. at parties).	-1	6	-1
14	... food hubs are needed (i.e. places where surplus food is gathered, sorted, distributed, or processed and marketed for human consumption).	2	-1	5
15	... menu choices should be limited.	-3	0	0
16	... a levy should be imposed on food imports.	-3	-4	-4
17	... more research should be done on alternate processing for edible residues in food processing plants.	1	1	1

18	... more research should be done on extending the shelf life of food.	3	0	-2
19	... more food should be ordered on demand.	2	4	-2
20	... less food should be produced.	3	-6	-5
21	... the diet of consumers should change.	1	-4	0
22	... food waste collection should become more expensive.	-3	-1	0
23	... persons involved in food processing should be better trained.	-4	3	2
24	... it should be mandatory that all food is harvested.	-4	-2	2
25	... food should be handled more carefully.	1	-1	-2
26	... more seasonal and local food should be consumed.	3	-5	5
27	... consumers should use new tools such as smart fridges and apps that track the shelf life of products.	4	-1	-5
28	... all actors in the food chain should cooperate better.	6	2	4
29	... better estimates of expected retailer sales should be made.	5	2	-1
30	... better estimates should be made of expected sales at restaurants.	5	1	-3
31	... consumers should plan their purchases better.	4	4	1
32	... consumers should process leftovers more often.	3	5	1
33	... consumers should eat more healthy food.	-1	-3	0
34	... aesthetic standards for food should disappear.	-3	-1	6
35	... logistics and distribution systems should become smarter.	3	1	3
36	... food safety rules should become less stringent.	-5	-2	1
37	... there should be no more food advertising campaigns.	-5	-3	-4
38	... there should be more local stores.	-4	-3	0
39	... there should be fewer varieties and brands of one product.	1	-3	-1
40	... there should be rules about standardising packaging.	1	-5	-3
41	... crops for human consumption should only be consumed by humans.	-5	0	-3
42	... restaurants should be labelled according to the amount of food they have thrown away in the past year.	-3	-1	-4
43	... catering establishments should prepare less food.	-1	0	-2
44	... ready-to-eat meals and fast food should disappear.	-4	-3	-2
45	... farmers should have more influence on the price for their produce.	4	-5	4
46	... longer shelf-life products should not be placed on shelves until previously expired products have been sold.	0	0	0
47	... more genetically modified products should be grown or cultivated.	-1	-2	-6
48	... more meal boxes should be ordered and prepared.	-2	1	-6
49	... more products should be sold without expiry dates.	0	0	3
50	... more fresh products should be frozen.	0	1	-1
51	... consumers should be less picky.	-1	3	1
52	... people would be willing to take the remaining food from the fields after harvest (i.e. gleaning).	-2	1	2
53	... surpluses should reach food aid organisations more often.	2	4	3
54	... products should include a better description about the ideal storage place and method.	2	2	1
55	... products should have a label indicating food miles.	-1	-4	0
56	... products should be labelled to reflect how much food was lost to reach the final product.	-2	-2	1
57	... subsidies for agriculture should be calculated differently.	0	-2	5
58	... different sizes of packaging should be available.	1	2	-1
59	... different sizes of dishes should be available.	0	3	-1
60	... food processing plants should be equipped with the best available technology.	1	3	0
61	... shops should reduce their offerings.	-2	0	-1
62	... shops should still offer products that exceed the "best before" date.	-2	-1	2
63	... food discounts should not be allowed.	-6	1	-3

Table 3. overview of the identified factors

	Perspective 1	Perspective 2	Perspective 3
Label		<i>will be decided later</i>	
No. of Q-sorts	9	9	8
Participants	P6, P7, P9, P11, P12, P17, P20, P21, P25	P3, P4, P5, P13, P15, P19, P23, P24, P27	P1, P2, P10, P14, P16, P18, P22, P26
Eigenvalue	5.19658	4.80170	4.12383
Variance	19.25%	17.78%	15.27%
Cumulative variance	19.25%	37.03%	52.30%

5. DISCUSSION

5.1. Description of the identified perspectives.

Perspective 1: FLW is an economic problem, and market mechanisms will restore this.

Those loaded on the first perspective frame the problem of FLW in the first place as an economic problem. The two most preferred actions within this perspective are actions that cover the full food supply chain, specifically better cooperation (#28, +6) and measurement of all food flows (#6, +6). Participant 9 said about the latter statement *mapping food loss and waste, will not cause a decrease. But not knowing where it occurs stops a lot*. Moreover, the first perspective thinks that there is a lot of room to improve the estimates of the expected sale, in the retail (#29, +5) as well as in the food service (#30, +5). Participant 7 formulates it as, *we already estimate that, but if we could know even better, it would be very useful to adjust our production apparatus accordingly*. Most of the other highly ranked statements target the distribution and logistics or the consumers. For the consumers, the most emphasis is put on a better knowledge of the expire date (#5, +5), followed by making use of new technology to keep track of shelf life (#27, +4), better planning of purchases (#31, +4), and process leftovers more often (#32, +3). Eating the leftovers will have as a *consequence that less is bought. And fewer purchases means that less has to be produced and, in that sense, fewer products have to be destroyed* (P12). Which emphasize the power of the market to restore itself.

At the same time, there is clear interest in technical measures. While, in general, interest in institutional measures is lower. This is in line with what participants indicated during the interview, e.g. participant 11: *government intervention, restrict commercial freedoms, these are things we are allergic to*, a similar reaction was noticed by participant 7: *and all that regulation, I am less in favour of that*. As this first perspective strongly beliefs in self-regulating markets, *let us apply the free-market principle, and let commercial freedom not be restricted* (P11), the specific actions that are least preferred are: using financial incentives (#9, -6) banning discounts (#63, -6) and advertisements (#37, +5) on food. In addition, this perspective beliefs that also lower alternatives for the food loss and waste such as feed or digestion are good alternatives (#41, -5). *It is mainly about why do you want to start reducing FLW. It is about impact, on the environment and then I think the total picture should be looked at and that we cannot look so narrowly, just at food for people. I think if there can be a revaluation of the products and that does go towards feed, then I do not really see that as such a huge problem* (P9). Participant 6 goes a step further and states that *animals consume a lot of surpluses that just are not available to humans. But often we have to feed some high-value products to upgrade those low-value surpluses into high-value products as well*.

Perspective 2: FLW is an ethical concern, and consumers need to take action.

Those aligned on the second perspective had a focus on the consumers, *the most important stage is the end, the consumer and their often-lacking knowledge* (P5). Which results in a high ranking of statements such as: creating more awareness about the consequences of food loss and waste (#10, +6), getting rid the idea that a lot of food should be offered (#13, +6), better knowledge of the expire dates (#5, +5), planning purchase more carefully (#31, +4), processing leftovers more often (#32, +5), and being less picky (#51, +3). Furthermore, perspective 2 targets the food service, by placing the action asking if nuts, bread, etc. are wanted, before serving (#1, +5) on the very right side. Participant 27 thinks that *we can expand that to other things as well. [...] It is a matter of just inquiring what is really needed at the table and then serving that instead of just automatically serving it*. Next, also the use of the doggy bag can be extended, by making it the default (#4, +4) and restaurants should make different sizes of dishes available (#59, +3) or go even further and serve smaller portions (#2, +2). On the other hand, this perspective has an aversion for actions that focus on the primary producer: urban agriculture (#8, -6), alternative proteins (#7, -4), more influencing the price (#45, -5). Although, producing less (#20, -6) is not a preferred action, they belief *it is the wanted outcome of all the other actions* (P4). However, this perspective has not really a preference for one type of measures, they do have a slight preference for societal and technical measures over institutional measures.

Perspective 3: FLW is an ethical and environmental concern, and everyone must take action.

Distinctive for all the participants that are loaded on the last perspective is that they have an activist point of view. They all work on smaller or larger initiatives that try to make real changes, such as short chain initiatives, SME's that prepare new food products from otherwise discarded ingredients, and more traditional environmental NGO's. *I think wasting is a logical side effect of the greatness of how we handle food nowadays* (P14); this quote shows that the third perspective is very in favour of shorter food chains, i.e. consuming more local and seasonal food (#26, +5). Moreover, they do see the problem of FLW as an environmental and ethical issue but not as an economic problem. *Currently, for the old food system, it is not an economic problem. Because basically all the barriers have been removed. They recover the VAT, they have organisations or hip apps that come and get [the food], so they do not have any logistics costs on those food losses. So yes, for them it is quite easy* (P1). Participant 10 continued on this and stated that *there could be some more mandatory measures. It should not all be optional, in terms of food loss and waste [prevention]*. This explains why using more financial instruments (#9, +6) and changing the calculation of the agricultural subsidies (#57, +5) are ranked on the very right of the Q-grid. Although this may give the impression that perspective three prefers institutional measures, they ranked societal measures higher. And this perspective dislikes technical measures.

In addition, those participants placed emphasis on items related to the entire food supply chain, such as: disappearance of aesthetic standards (#34, +6), better cooperation within the food supply chain (#28, +4), develop a measurement network that maps all food flows (#6, +4), create more awareness about the consequences of FLW (#10, +4), and surpluses should reach food aid organisations more often (#53, +3). By contrast, this perspective does not prefer actions that target the food service or the processing industry. They argue that serving less (#2, -4) or other actions that target the food service, will reduce the cosiness and fun which is typical for a restaurant. But they see the least potential in GMO's (#47, -6) and meal boxes (#48, -6). About this last one, participant 16 said: *on a consumer level, I do agree that less food will be wasted, but more food may have been lost in the steps before*.

5.2. Similarities and differences between perspectives

With an effect size of one, we were able to identify 18 consensus and 26 distinguishing propositions. The positive consensus propositions are important because this will show which measures are seen as potential solutions by all identified factors. Whereas the negative consensus statements will show which possible solutions will not receive any support.

Firstly all perspectives think that there is room for improving the knowledge on the 'best before' and 'use by' date (#5, +5, +5 and +3). As stated by participant 3 (F2), *many people still do not know the difference between the two. And therefore, throw away things that are still perfectly edible*. Participant 1 (F3) is even somewhat frustrated about the confusion on the due dates, *that is a no-brainer and I do not understand why we still need to talk about it these days*.

A second consensus statement is sending surpluses more often to food aid organisations (#53, +2, +4 and +3). With the exemption of participant 12 (F1), has everyone ranked this solution positive or neutral. Participant 12 his argument is that *the fight against poverty and the fight against FLW are two separate aspects, which require very different efforts. ... I think that [food aid] also counteracts the fight against food loss and food waste. Donation stops producers and retailers from implementing a more performant policy around FLW, and on the other hand food banks are overloaded with all kinds of material for which there is often no demand. Of course, there is a partial truth to that, that it is good, that it is still consumed, that it still gets to those people. But it is now in such a disproportion*.

Thirdly, better cooperation between the actors in the food supply chain (#28, +6, +2 and +4) is needed according to all three perspectives. Participant 21 (F1) framed it as follow: *our organisation is convinced that many of the answers - which we often do not know yet - are there if we get all the chain actors around the table together. And to make sure that those have an equal voice at the table. So if we get that straightened out, I can imagine that the issue of food loss and waste can also be addressed*. Different respondents refer to the interaction between farmer and purchaser that can be better: *if better agreements are made there, e.g. so much will be purchased, at that quality standards, at that price. Yes, in that way*

I think you can already avoid a very important part of FLW, especially in the case of products that expire easily, like fresh vegetables and fresh fruit (P15, F2) or what occurs now is that, for example, the processing industry communicates a date: we want your carrots tomorrow. And that can be on a moment that it is not ideal to harvest, resulting in more losses. So if that can be coordinated, then you can certainly prevent some of that (P6, F1).

A last point of consensus is raising awareness about the effects of FLW (#10, +2, +6 and +4). Since a lot of people do not know how many food they lose or waste, let alone knowing the consequences. So it is assumed by a lot of the respondents that, if they know the consequences, they will act differently. *I think most people (not just consumers, but also producers and processors etc.) – I really believe that – are good. Yes, if those know what they are cooperating with, they are going to stop doing that or try to minimise it anyway (P14, F3).*

Conversely, a list of actions not supported by any point of view was identified, we will discuss the four most outstanding ones. First, no perspective thinks that banning advertisements campaigns (#37, –5, –3 and –4) will solve the problem of FLW. Remarkable is that all factors have their own reason, for factor 1 it is a violation of the free market: *should the ads not help, they would disappear as soon as possible, so the market regulates itself. There is no need for the government to intervene there as well (P11).* Whereas factor 2 thinks that advertisements can be very useful if the supply is high: *I even sometimes think that advertising campaigns can be useful to get people to go up there at certain times (P4).* Perspective three is the most stringent in this, *I would not necessarily ban all advertising, but it is true that there may be strict conditions. And as far as we are concerned, advertising is still too much in function of the industry and too little in function of the public interest (P10).*

A second measure that cannot account for any support is a tax on food import (#16, –3, –4 and –4). Again, the argumentation differs between the perspectives. For the first perspective this is just as before too much governmental interruption. Factor 2 does not see the connection between import and FLW, *it is not because an apple is harvested in New Zealand that it has a greater chance to become food loss or waste compared to a Belgium apple (P4).* In addition, they fear that *it will just move the problem, because farmers abroad are not going to be able to sell their food and then food losses are going to happen there (P15).* Factor 3 again believes that some restrictions are necessary, *we do support a local food system, but we are also realistic about it and we are always going to import certain food products. But playing with mechanisms in what comes into our country is something we definitely want to think about (P10).* The third negative consensus statement handles about a label for the food service that indicate their food waste (#42, –3, –1 and –4). All participants think that we currently have enough labels, and that consumers not really bother about it. *An extra label is not going to mean anything. How many labels do we already have ... Infinite? What do they say? (P5, F2).*

And a last outstanding negative consensus statement is, disappearance of fast food and ready to eat meals (#44, –4, –3 and –2). For this item, the connection is not always clear for the participants.

Besides these consensus statements, there are as well distinguishing items. A statement that stands out among these is the use of financial incentives (#9), while factor 3 (+6) as well as perspective 2 (+3) see the potential of this action, factor 1 is completely against (–6). Which is in line with perspective one's idea that market mechanisms will solve the problem and that government interference is not desired. Another notable item is the one about more local and seasonal consumptions (#26), which is very important for the third factor (+5) and is acknowledged by the first factor as a potential solution (+3). But is definitely not a wanted direction for the second factor (–5). *That may have other benefits, but to reduce FLW, I do not really think that consuming more local and seasonal is going to trigger that (P15, loaded on F2).* A third distinguishing statement is increasing the influence of the primary producer on food prices (#45), again factor 1 and 3 see the potential (both +4) however factor 2 does not believe in its effect on the FLW (–5).

5.3. Limitations of the study

We are aware, that the study also contains some shortcomings. For instance, the scope of the study is limited to prevention and human reuse of food loss and waste. This means that lower circular strategies with high valorisation, such as conversion to animal feed, reuse and recycle food into high value products (e.g. pharmaceuticals), nutrient recycling (e.g. to improve soil) or biofuels, were not

considered. Although this is a limitation, we assume that all actors prefer higher circular strategies over lower ones. In addition, the focus is on the Flemish food system, which differs from other food systems that exist globally and is strongly linked to food production and consumption elsewhere in the world. We tried to focus as many items as possible on Flanders, however, this was not always possible. Finally, a shortcoming of the Q method is that it is only capable of finding out the *quantity* of perspectives and the *why* behind the perspectives (Minkman & Molenveld, 2020). It is not possible with a Q-method to know the representation of perspectives in the wider society. We would like to address this last shortcoming in a follow-up study.

6. CONCLUSION

Flanders is experiencing a slight decrease – 2.6% between 2015 and 2020 – in food loss and waste, but this decrease seems insufficient to achieve the target of halving the food loss and waste by 2030. For this reason, additional actions that ensure prevention and human reuse of food scraps are needed. Efforts are needed from everyone in the food supply chain. To minimise resistance, it is important to know which actions find the most support, what type of measures are preferred, and which actors should make the greatest effort. This is not a one-size-fits-all answer, it was expected that there are different views on solving the food loss and waste problem. We therefore made use of the Q method, which identified three perspectives on reducing the food loss and waste in Flanders.

The first perspective frames the food loss and waste problem as an economic issue. This perspective includes nine of the stakeholders. They have a rather ambiguous preference for one actor in the food chain to tackle the problem, they divide the responsibility between the entire food supply chain, the households, distribution and logistics and, to a lesser extent the processing industry. In addition, they have an aversion of governmental intervention, as a result institutional measures are not desired. The two actions that will have the greatest impact according to these respondents are: mapping all the food flows in the system and a better cooperation between all actors.

The second perspective also consists of nine stakeholders, they frame the food loss and food waste problem as an ethical one. This perspective prefers actions that target the consumer and the food service, whereas they dislike the actions that focus on the primary producers. Moreover they like a combination of measures with the most emphasis on societal measures and in a lesser extend technical and institutional measures. Respondents who are loaded on the second perspective think that raising awareness and reducing the social standards that always a lot of food must be served will have the most potential.

The third perspective includes eight participants, who want to change the food system since they see food loss and waste as a result of the current system. The actions they prefer the most focus on the full food supply chain or on the primary producers. In contrast, they do not like actions that target the food service. They have trust in societal actions, supported by some institutional actions and in a lesser extend in technical measures. That is why this perspective ranked the financial incentives on the very right, as well as the disappearance of aesthetic standards.

Furthermore, we were able to identify 18 consensus statements, four of those were high ranked by all three perspectives. This means that they form potential entry points for change. A first point of consensus is the need to enhance the knowledge about the due date. Next the three perspectives see the potential of sending surpluses more often to food aid organisations (#53, +2, +4 and +3). In addition, better cooperation between all actors in the food supply chain (#28, +6, +2 and +4) and raising awareness about the effects of FLW (#10, +2, +6 and +4) are ranked on the right side of the Q-grid by all factors.

This research tried to add value to the research on food loss and waste and the Q method, in three different ways. First, to the researchers' knowledge, this is the first study that questions stakeholders on actions to reduce food loss and waste along the entire food supply chain. Until now, research has always focused on one or a few stages. Second, a matrix (i.e. two dimensions) was used to structure the Q-set. Although this has been done before, it is not yet a mainstream practice. Finally, the relatively recently developed Stata Commando for by-person factor analysis was used, some papers have been presented on this too but again this is not mainstream practice.

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APPENDIX A. translation of the interview guideline

Introduction: sending an invite for the Q-sortware program, introducing the researcher and the research project and explaining the structure of the interview.

First part:

Can you tell something about yourself and the company/organization you work for?

If not clear enough: How are you currently working on the topic of food loss and waste?

If not clear enough: Where would you position your organisation and your function in the food supply chain?

Make it clear that they should fill in the Q from that perspective, rather than their own opinion.

How do you see food loss/waste?

Afterwards, give the definition.

What is your view on the problem of food loss: environmental, social/ethical, economic problem or something else?

In what way do you think we can best solve the problem of food loss and waste?

If not clear enough: Which sectors do you think should be tackled first?

Q-sort (second part):

You normally received an e-mail just before our meeting started containing a link, this will take you to an online tool where you can perform a Q-sort. The Q-sortware is very logically structured. You will first have to give permission to participate in the study (see also documents sent in advance). Afterwards, the Q-sort begins.

You will be shown 63 statements these include measures that could reduce food loss, you should then sort these in one of 5 columns: (totally) disagree, neutral or (totally) agree. This sorting is not final, you can always make adjustments, even in the second step deviations are still possible. When you are completely satisfied with this first sorting, you can click to the next page.

! You may want to turn off your micro and camera during the sorting so that you can work in peace. I will leave my camera on and my mic off so that you are not disturbed but can always report your questions/comments to me.

... participants took about 10 to 15 minutes to fill out the first step ...

Now, you will see the same statements in the 5 categories as you have sorted them. Now you need to sort the statements further. Recommended is to look at the "totally agree" column first and choose the two statements that you think will have the most effect to reduce food loss. You then place these on the far right. Next, choose the three statements that will have slightly less effect and so on until the column is empty. Afterwards, continue with the "agree" column. (Again, you may deviate and place statements that were previously under "agree" now under "disagree" etc.).

After the "(totally) agree" columns, you can continue with the "(totally) disagree" columns, in the same (first the two statements you disagree with most, then the next three ...). Finally, you will have some empty space in the centre of the table, you can then place the statements from the "neutral" column in the distribution.

! Keep in mind that this is about relative positioning, placing something at completely disagree does not necessarily mean that you disagree but rather that you agree the least compared to the other statements.

! The propositions sorted on the far left/right will be discussed later. If there are any other propositions you like to discuss please write down the keywords and we will discuss them later.

... participants took about 10 to 30 minutes to fill out the second step ...

! please revise your answers before submission

When you have finished, it is important to indicate that your answers should be saved.

Exit interview (third part):

Can you explain why you think this statement (-6, -5, +5 and +6) has no/much potential?

Interpretation of the statement

In what way do you think food loss/waste can be reduced with this action?

Are there other items you would like to discuss (was already mentioned before)?

Are there any aspects that you feel were missing from the statements?

→ YES: can you formulate this as a statement and place it in the distribution?

Snowball sampling: are there people/organisation who you think have a similar opinion? And is there someone with a totally different point of view?

APPENDIX B. decision on Stata command settings and on the number of factors

Stata command settings

```
qfactor varlist [if] [in], nfactor(#) [extraction(string) rotation(string)
      transpose(string) statement(string) score(string) esize(string)
      bipolar(string)]
```

Most analysis find between three and seven factors (Dziopa & Aher, 2011), we tested this in the Stata command. We opted for the principal component analysis since this was, taking the criteria into account, the only extraction method that was able to extract three factors (appendix, table B1).

The current Stata command provide three extraction methods: principal component factor (`pcf`), principal axis factor (`pf`), and iterated principal axis factor (`ipf`).

Table B1. Comparing extraction method

	Kaise-Guttman	variance	Cumulative variance	Humphrey's first rule	Humphrey's second rule	CONCLUSION
pcf	Max. 7	Max. 4	Min. 3	Max. 7	Max. 3	→ 3
pf	Max. 4	Max. 4	Min. 2	Max. 6	Max. 2	→ 2
ipf	Max. 3	Max. 5	Min. 1	Max. 7	Max. 2	→ 2

The rotation can be done via: `varimax`, `quartimax`, `equamax`, `promax(#)`, `oblimin(#)`, and `target(Tg)`. We tested them all except for the targeted rotation, since it would be too inefficient to make a rotation matrix ourselves.

The `Quartimax` and `Oblimin` rotations cause very unbalanced distribution of the respondents over the factors, i.e. 17 participants in factor 1 and only one participant in factor 3. Whereas the `Promax` rotation has a balanced distribution, however six of the Q-sorts cannot be loaded on a factor due to insignificance or confusion. That leaves only `varimax` and `equamax` rotation, between which the difference is very limited. When using `varimax` rotation participant 8 is not loaded, whereas P8 is loaded on factor 3 when making use of `equamax` rotation. Similarly, participant 21 is not loaded when using of `equamax`, while P21 is loaded on factor 2 when making use of `varimax` rotation.

Table B2. Comparing rotation method

	Confounding	Insignificant	Number of participants by factor
Varimax		P8	9 9 8
Quartimax	P16, P24		17 7 1
Equamax	P21		9 8 9
Promax	P5, P16	P8, P13, P19, P21	8 6 7
Oblimin	P16, P24		17 7 1

The `qfactor` command has four options to specifies how the factor scores are calculated (`Brow`, `regression`, `Bartlett`, and `Thompson`).

Table B3. Comparing score calculation method

	brown1	brown2	brown3	reg1	reg2	reg3	thompson1	thompson2	thompson3	bartlett1	bartlett2	bartlett3
brown1	1.000											
brown2	0.6498	1.000										
brown3	0.3432	0.3380	1.000									
reg1	0.9251	0.4146	0.1812	1.000								
reg2	0.2753	0.8659	0.2491	0.0000	1.000							
reg3	0.1951	0.1585	0.9477	0.0610	0.1010	1.000						
thompson1	0.9408	0.4652	0.1934	0.9861	0.0610	0.0645	1.000					
thompson2	0.3763	0.9251	0.2805	0.1028	0.9791	0.1220	0.1638	1.000				
thompson3	0.2456	0.1986	0.9634	0.1080	0.1289	0.9895	0.1167	0.1533	1.000			
bartlett1	0.9251	0.4146	0.1760	0.9861	0.0017	0.0540	0.9913	0.1063	0.1010	1.000		
bartlett2	0.3101	0.8955	0.2491	0.0366	0.9843	0.0923	0.0976	0.9895	0.1220	0.0383	1.000	
bartlett3	0.1760	0.1324	0.9477	0.0470	0.0854	0.9930	0.0505	0.1045	0.9895	0.0383	0.0767	1.000

Factor Criteria

- The Kaise-Guttman criterion: Eigenvalues indicate the strength and explanatory power of a factor, for this reason only factors with an Eigenvalue larger than 1 will be included (D'Amato et al., 2019; Watts & Stenner, 2012).
- Cattell's scree test: Eigenvalues (y-axis) – obtained through a principal component analysis – are plotted in a graph against increasing number of factors (x-axis). All plotted dots are connected, the point where the line change slope, indicates the optimal number of factors (Watts & Stenner, 2012).
- Humphrey's first rule: at least two significant (at the $P < 0.01$ level) loaded Q-sort per factor (D'Amato et al., 2019; Sneegas et al., 2021; Watts & Stenner, 2012). Other auteurs (Dziopa & Aher, 2011) recommend 4 to 5 significant Q-sorts, to have a reliable factor. A calculation of Brown (1980, p. 222) can be used:

$$\text{significant factor loading} = \frac{2.58}{\sqrt{\text{no. of items in the Qset}}} \rightarrow \frac{2.58}{\sqrt{63}} = 0.325$$

Factor loadings are correlations that indicate in which extent a Q-sort is associated to each factor (Akhtar-Danesh, 2018).

- Humphrey's second rule: a factor is significant if the cross-product of the two highest (absolute) loadings exceeds twice the standard error (Watts & Stenner, 2012).

$$\text{standard error} = \frac{1}{\sqrt{\text{no. of items in the Qset}}} \rightarrow \frac{1}{\sqrt{63}} = 0.126$$

- No significant correlation between two factors: if there are two (or more factors) with a correlation that is significant (same calculation as above), then we can assume that those factors represent a very similar point of view and reconsideration of the factors is appropriate (Watts & Stenner, 2012). Other research changes this criteria to: a correlation that is smaller than 0.33 (Minkman & Molenveld, 2020). In general, it can be said that the lower the correlation, the better.
- Explaining power or variance: Each factor must have an explanatory value of at least 3% (Minkman & Molenveld, 2020). Other scholars recommend an explanatory value of at least 10% (Sneegas et al., 2021).
- Cumulative variance: the factors explain collectively at least 50% of the total variance (Sneegas et al., 2021).
- Insignificant Q-sort: these are Q-sorts that are not significantly loaded on any factor (Sneegas et al., 2021).
- Confounded Q-sort: these are Q-sorts that are significantly loaded on two or more factors.

Researchers should try to limit the number of insignificant and confounded Q-sorts (Sneegas et al., 2021).

- The factor must be of theoretical importance and the findings must be logical (Minkman & Molenveld, 2020).