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How to reduce food waste in public catering units?

– A case study at twelve school canteens in Sala municipality, Sweden

Malou Tromp

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Author: Malou Tromp

Supervisor: Christopher Malefors, Department of Energy and Technology, SLU
Examiner: Mattias Eriksson, Department of Energy and Technology, SLU

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Abstract

In developed countries, food is to a significant extend wasted at the consumption stage, meaning that it is discarded even if it is still suitable for human consumption. The further along the supply chain food is wasted, the more resources are lost and the higher the environmental impact is. Therefore, it is important to find ways to reduce food waste at a consumer level. In literature, different interventions are suggested to reduce food waste. However, there are not many studies that have quantified the impact of introducing these kinds of interventions. This study assesses the effect of food waste reduction interventions in public catering units in Sala municipality to see if they have the desired reduction effect. The interventions researched in this study are: "tasting spoon", "plate waste tracker", "awareness campaign" and "demand forecasting". To assess the effects of the interventions the levels of food waste, after implementing the interventions, are compared to previous food waste levels. To verify the effect a control group, who did not take part in any interventions, is used. In addition, a survey is conducted to verify the quantification results, assess the correlation between the amount of waste per portion and the number of actions taken to reduce food waste and identify potential areas of improvement for the studied catering units. The results indicate that most of the public catering units where an intervention was introduced, had the desired reduction effect. However, there may be other factors that have influenced the reduction in food waste. Besides, some catering units have a misconception about where in their production process they produce most food waste and overestimate the number of guests they have daily. These misconceptions may cause catering units to focus on the wrong problem and/or generate more food waste. This study is a good basis for how the effect of introducing interventions for reducing food waste can be quantified and examined. With some improvements to the method, this may become a helpful tool for municipalities and catering units to examine which interventions are most viable for implementation.

Keywords: Food waste, food waste reduction, sustainable development, public catering units, interventions, SDGs.

Summary

Food waste is a problem with economic, environmental and social implications, making it both important and complex. In developed countries, food is to a significant extend wasted at the consumption stage, meaning that it is discarded even if it is still suitable for human consumption. The further along the supply chain food is wasted, the more resources are lost and the higher the environmental impact is. Therefore, it is important to find ways to reduce food waste at a consumer level. In literature, different interventions are suggested to reduce food waste. However, there are not many studies that look at how the impact of introducing these kinds of interventions can be quantified. This study assesses the effect of food waste reduction interventions in public catering units in Sala municipality to see if they have the desired reduction effect. The interventions researched in this study are: "tasting spoon", "plate waste tracker", "awareness campaign" and "demand forecasting". To assess the effects of introducing a new intervention the levels of food waste, after implementing the intervention, are compared to food waste levels from the years before. In addition, the studied catering units are asked to fill out a survey to get a general overview of the catering units and see how much action they take to reduce food waste. The results indicate that most of the public catering units where an intervention was introduced, had the desired reduction effect. However, there may be other factors that have influenced the reduction in food waste. Besides, some catering units have a misconception about where in their production process they produce most food waste and overestimate the number of guests they have daily. These misconceptions may cause catering units to focus on the wrong problem and/or generate more food waste.

Keywords: Food waste, food waste reduction, sustainable development, public catering units, interventions, SDGs.

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1. Introduction

Roughly one-third of all food produced in the world gets lost or wasted from agricultural production down to final consumption. This is about 1.3 billion ton per year (FAO, 2011). Food production systems have a major impact on the environment. The global food system is a major driver of biodiversity loss, climate change, land-use change, freshwater depletion and pollution of aquatic and terrestrial ecosystems through nitrogen and phosphorus run-off from fertilizer and manure application (Campbell et al., 2017; FAO, 2011; Springmann et al., 2018). Therefore, throwing away food is a waste of resources including water, land, energy, labour and capital and leads to an unnecessary impact on the environment. Reducing food loss or waste is widely seen as an important way to improve food security and nutrition, contribute towards environmental sustainability, reduce production costs and increase the efficiency of the food system (FAO, 2019). In 2016, the United Nations (UN) published the Agenda 2030 for Sustainable Development with its 17 Sustainable development Goals (SDGs) with 169 associated targets. The Agenda 2030 is a blueprint to achieve a better and more sustainable future and was adopted by the 193 Member States of the UN. SDG 12 provides several targets to work towards more sustainable consumption and production patterns (UN, 2015). SDG target 12.3 specifically addresses food waste and loss and calls for halving per capita global food waste at retail and consumer levels and reducing food loss along production and supply chains. According to the declaration of the agenda, all countries can determine their own national goals adapted to national conditions guided by the global level of ambition (Naturvårdsverket, 2020a; UN, 2015).

Food loss or waste occurs throughout the whole food supply chain. In developed countries, food is to a significant extend wasted at the consumption stage, meaning that it is discarded even if it is still suitable for human consumption (FAO, 2011). When looking at the entire life cycle of a food product, every phase leads to additional environmental impact and added value. This is why the further along the supply chain food is wasted, the more environmental impact and loss of resources accumulates (FAO, 2013, 2011). Therefore, reducing food waste at the consumers level can have a big impact. Restaurants, public catering units and households are part of the consumption level. In Sweden, the public catering sector is relatively

large. Every day, approximately 2.9 million meals are served in public catering units in Sweden (Livsmedelsverket, 2020a). Public catering units are found in schools, preschools, nursing homes, hospitals and prisons (Naturvårdsverket, 2020a). In 2018, about 75,000 ton of food waste was generated in the public catering sector in Sweden which is accounted for 6% of the national food waste. In this sector, the largest amount of this food waste, which is close to 51,000 ton, was generated in schools and preschools (Naturvårdsverket, 2020b). Food waste in public catering units occurs in the kitchen (kitchen waste), during serving (serving waste) and from the guests' plates (plate waste) (Figure 1).

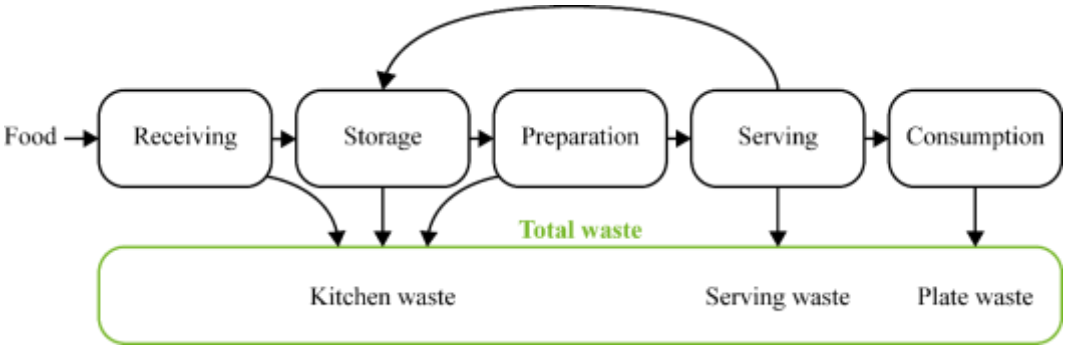

Figure 1. The process and the associated waste generating processes within a public catering unit. Based on figure 1 form Malefors et al., 2019.

The reason food waste occurs can vary a lot per catering unit (Arvidsson, 2019; Steen et al., 2018). There are a lot of articles that discuss specific strategies, policies and outcomes of food waste reduction in public catering units inside and outside of Sweden (Rainer, 2019). In 2016, the city of Gothenburg introduced a model to reduce food waste in public catering units, also known as the "the Gothenburg model for lesser food waste" (Göteborgs Stad, 2016). The model provides a practical tool in the form of a checklist to reduce food waste through simple measures and better routines. In the municipality of Gothenburg, the implementation of the model led to a decrease in food waste in public catering units by approximately 50% from January 2017 to December 2018 (Östergren and Backlund, 2019). However, the current version of the Gothenburg model does not include plate waste and only focuses on kitchen- and serving waste because the catering units have control over these two. To make a more holistic tool for reducing food waste in public catering units the Swedish National Food Administration made "The handbook for reducing food waste" (Livsmedelsverket, 2020b). In this handbook, the National Food Administration supplemented the Gothenburg model with a section on plate waste, consumption measurements and the national method for food waste quantification (Livsmedelsverket, 2020b). This is a national document to give public catering units a guideline on how to quantify and reduce food waste in their kitchen.

Quantifying and reporting food waste to establish a baseline can be seen as the first step in the process towards food waste reduction (Eriksson et al., 2017; Livsmedelsverket, 2020b; UNEP, 2014). Understanding the nature and scale of food waste is a powerful basis, whether beginning a new programme of action or building on existing actions to reduce food waste (UNEP, 2014). Measuring food waste makes catering units aware of the food waste they generate and gives them insight on where and why it occurs (Eriksson et al., 2018; Livsmedelsverket, 2020b). Through the years several self-assessment tools to quantify food waste at public catering units are developed (Boschini et al., 2018; Derqui and Fernandez, 2017). In Sweden, the National Food Administration and researchers at the Swedish University of Agricultural Science (SLU) have introduced a national food waste quantification template where kitchens in the public catering sector can fill out their waste figures and so quantify their food waste (Livsmedelsverket, 2020c).

Between individual catering units, there are large variations in food waste even though they are allocated the same resources and face approximately the same challenges. Several studies have calculated the average food waste per portion served at school catering units which all gave slightly different outcomes. Previous quantifications of food waste within these school catering units are displayed in Table 1.

Table 1. Food waste quantification results from previously studied school catering units expressed in waste per portion (g).

Amount of units	Country	Average waste per portion (g)	Source
21	Portugal	49.5	(Liz Martins et al., 2014)
2	Sweden	80.5	(Engström and Carlsson-Kanyama, 2004)
10	Sweden	79	(Eriksson et al., 2017)
1	USA	210	(Byker et al., 2014)

Variation in results may be accounted for by the different assessment and quantification methods, because researchers may have a slightly different way of quantifying food waste (Betz et al., 2015). Besides, food waste is normally not caused by a single action or cause, but more likely by a chain of events where a combination of risk factors can have an increasing effect. Therefore, every catering unit has its own challenges. It is unlikely that a particular waste-reducing measure will have the same effect in all catering units. However, this does not necessarily mean that all catering units need individual solutions. To find solutions to decrease food waste in public catering units, the interventions must at least be based on actual problems arising in catering units and focus on waste generating hotspots (Eriksson et al., 2017).

In Sweden, municipalities or owners (if it is a private school) are primarily responsible for resource allocation and daily operations of school catering units, including school meals. (Livsmedelsverket, 2020d; Patterson and Elinder, 2015; SKR, 2020). When a public catering unit is a part of a bigger organization (municipality) the introduction of new food waste prevention interventions can be done from a top-down or bottom-up approach. A top-down approach means that a broad intervention is introduced in all catering units by the overarching organization. If they know what problem they have, the implementation of the intervention is mainly arranged and funded by the organization. However, the introduced intervention might not solve the problem for all catering units. A bottom-up approach means that a catering unit introduces an intervention based on actual problems that arise in their kitchen. In this case, there is a higher chance that the intervention will lead to food waste reduction. However, it could be more difficult to getting funding from the overarching organization for the implementation of these kinds of interventions. Both approaches have pros and cons and based on the type of organisation and the number of resources available one approach or a combination of both will be more in favour.

In literature, different interventions, such as educate the guests better (Rainer, 2019), handout smaller plates (Rainer, 2019) and cooking food onsite (Eriksson et al., 2016; Rainer, 2019) are suggested to reduce food waste in public catering units. Introducing interventions that help public catering units to reduce their food waste is a good step to work towards a more sustainable food system. However, there are not many studies that have quantified the impact of introducing these kinds of interventions. This study will attempt to create an example of how the effect of introducing interventions for reducing food waste can be quantified and examined. This study aims to assess the effect of food waste reduction interventions in public catering units and see if they have the desired reduction effect. To verify the effect, a control group, who did not take part in any interventions, is used. To assess the effects of the interventions the levels of food waste, after implementing the interventions, will be compared to previous food waste levels. In addition, a survey will be conducted to verify the quantification results, examine the correlation between the amount of waste per portion and the number of actions taken by the individual catering units studied to reduce food waste and identify potential areas of improvement for the studied catering units. All this is done as a case study on several school catering units in Sala municipality. For several years, these school catering units collected very detailed food waste quantification data, which makes it the perfect area to conduct this study.

2. Background

The background covers more information about the definition of food waste used in this study and how to deal with food waste. This chapter also gives an introduction to the phenomenon of school lunches in Sweden, Sala municipality as a case study and which policies are in effect on a national and municipal basis in Sweden.

2.1. Food waste definitions

Internationally, different definitions of food waste are used. There are ongoing discussions about what should be classified as food waste and what not. This means that definitions may change in the future, but also that it may be difficult to make equal comparisons of current quantifications. Establishing one common definition of food waste is an important step to achieve harmonisation of how food waste is quantified (FUSIONS, 2016). One common definition of waste can be used as a reference for food waste quantifications, monitoring and reporting through the whole food supply chain. In 2014, FUSIONS (Food Use for Social Innovation by Optimising waste prevention Strategies), a project funded by the European Union (EU), published the report "FUSIONS Definitional Framework for Food Waste". The framework was developed to provide a reference that could be used to identify and consequently quantify food waste on a homogenous basis all over Europe (FUSIONS, 2016). The proposed definition of food waste in this report is:

> "Food waste is any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed (including composted, crops ploughed in/not harvested, anaerobic digestion, bio-energy production, co-generation, incineration, disposal to sewer, landfill or discarded to sea)" (FUSIONS, 2014).

FUSIONS decision to also include inedible parts into the definition is because it can highlight the potential to turn food parts that are currently defined as inedible into edible, such e.g. as turning orange peels into marmalade (Silvennoinen et al., 2015). Besides, excluding inedible parts from the definition may lead to people forgetting to consider them even though improvements can be made in management

strategies for this resource flow as well (FUSIONS, 2014). However, it is recommended to quantify edible and inedible parts separately where possible.

In Sweden National Food Administration, made specific definitions for the food waste that occurs in public catering units. They divide the food waste that occurs in this sector in three categories: kitchen waste, serving waste and plate waste (Livsmedelsverket, 2020c):

- *Kitchen waste*: is the food waste that occurs in the kitchen, during storage, preparation and cooking.
- *Serving waste*: the food that is presented in the serving but is thrown away because it is not consumed.
- *Plate waste*: is the food on the guests' plate that is not eaten and thrown away.

These three definitions are used in this study. In all three categories, edible and inedible food waste can occur. Examples and definitions per sector are shown in table 2.

Table 2. Definition of edible and inedible food waste in the three categories: kitchen waste, serving waste and plate waste (Silvennoinen et al., 2015).

	Kitchen waste	**Serving waste**	**Plate waste**
Edible	Spoiled products, incorrectly prepared food, expired date products	Overproduction, food left from the buffet	Food leftovers by customers on plate
Inedible	Inedible parts of vegetables, peals, coffee grounds and bones	Inedible parts of vegetables, bones	Inedible parts of vegetables, bones

It is not always possible to separate edible and inedible parts of food waste, during food waste quantifications. Due to practical reasons, inedible parts of vegetables, bones and napkins are usually included in the quantification of serving waste and plate waste (Livsmedelsverket, 2020c).

2.2. How should we deal with food waste?

Reducing food waste is widely seen as an important way to improve food security and nutrition, contribute towards environmental sustainability, reduce production costs and increase the efficiency of the food system (FAO, 2019). To reduce food waste in a catering unit, the most preferred action is to prevent food from being wasted in the first place. However, it is not always possible to have no food waste at all (Reynolds et al., 2020).

In the last decade, several frameworks have been developed to illustrate how to manage food waste in terms of what is best for the environment. Examples of such tools are the Food Recovery Hierarchy in the United States (USEPA, 2015), the Food Waste Hierarchy (Papargyropoulou et al., 2014) and the Food and Drink Material Hierarchy in the United Kingdom (WRAP, 2016). All frameworks are more or less based on five steps to reduce food waste in order of preference: Prevention, Re-use, Recycle, Recover and Disposal. All frameworks prioritise prevention since that is the most resource-efficient. The other waste management options include downcycling and loss of the intended product (Naturvårdsverket, 2013).

Figure 3 shows the Food Recovery Hierarchy. The different steps in the Food Recovery Hierarchy are put in order from most to least preferred. The higher in the hierarchy, the higher the benefits for the environment, society and economy are (USEPA, 2015). The most preferred action is to prevent food from being wasted in the first place. However, if food surplus cannot be prevented, the second-best option is to redistribute food to people in need. There are two possible ways for catering units to utilise surplus food: sell it at a slightly reduced price after the buffet has been closed or donate it to charity (Reynolds et al., 2020). The third option is to use the food surplus for animal feed. The fourth option is to use the surplus for an industrial purpose as using it for the production of biogas. The fifth option is to use the food surplus as compost to feed and nourish the soil and the last and least preferred option is to dispose the food surplus or send it to a landfill, which is not allowed in a Swedish context (Naturvårdsverket, 2013).

Figure. 2*. The Food Recovery Hierarchy (USEPA, 2015).*

2.3. School lunches in Sweden

Public catering is a large sector in a Swedish context. Daily free lunch meals are served to all children between the ages of 7 and 19, regardless of parental income (Livsmedelsverket, 2020d). This makes Sweden one of a handful of countries in the world that provides this kind of school lunch service (Patterson and Elinder, 2015). Most of the school lunches in Sweden are served as a buffet. Every day about two or three hot meal alternatives are available. Besides that, salad, hard bread, butter, milk and water are also on the menu. The served meals are planned with the Swedish meal model for school meals in mind, which is created by the National Food Administration (Figure 3) (Livsmedelsverket, 2020e). The meal model consists of six pieces explaining the most important parts of the meal: Tasty, Integrated, Pleasant, Sustainable, Nutritious, and Safe. The parts nutritional and safe are important from a health perspective. However, if the food is not tasty and pleasant it will not be eaten. As for the sustainability of the food, the focus is on environmental and social sustainability. Integrated refers to the meal being a resource (energy) for education. (Arvidsson, 2019)

Figure 3. The Swedish meal model for school lunches (Livsmedelsverket, 2020e).

School lunches and the local public catering units are each municipalities responsibility (Livsmedelsverket, 2020d; SKR, 2020). Public catering units can be divided into two kinds of kitchens, either: a production kitchen or a satellite kitchen (Malefors et al., 2019; Östergren and Backlund, 2019). A production kitchen cooks and prepares all the food they serve on-site. A satellite kitchen is a kitchen that can prepare some meals but mainly relies on deliveries from a production kitchen. Satellite kitchens normally cause more food waste than production kitchens (Eriksson et al., 2016; Naturvårdsverket, 2009). This is due to the fact that satellite kitchens lack the opportunity to cook food in smaller batches and order more food than needed to make sure they have enough food. In addition, they often lack the ability to save leftovers for a later occasion because of an absence of proper possibility to cool down and store the food (Eriksson et al., 2016).

2.4. Sala municipality as a case study on food waste in public catering units

This study was done in collaboration with Sala municipality. Since 2014, Sala municipality has executed very detailed food waste quantifications at the public catering units within their municipality. This makes it an interesting area to study. Sweden can be divided into 290 municipalities. Sala municipality is located in Västmanland county in the middle of Sweden (Figure 4) and has a population of 22,894 people (Sala Kommun, 2015; SCB, 2019).

Figure 4. Location Sala Municipality in Sweden (Sala Kommun, 2015).

Already in 2016, a study was conducted regarding food waste in Sala municipality's public catering units (Eriksson et al., 2016). This study analysed how different risk factors and proposed interventions affect food waste in public catering units. As a result, several risk factors were identified (Eriksson et al., 2016; Sala Kommun, 2020a). Based on the identified risk factors several interventions were proposed that could help to reduce food waste. As a result, several changes were made in Sala municipality's catering units (Boström, 2020). Table 3 shows the identified risk factors, the proposed interventions and where the interventions were implemented by the municipality.

Table 3. The identified risk factors, the proposed interventions and where the interventions were implemented (Boström, 2020; Eriksson et al., 2016).

Risk factor	**Leads to increase in**	**Proposed intervention**	**Implementation (catering units)**
Serving waste in satellite kitchens are higher than in production kitchens	Serving waste	More kitchens on site	2 schools
Total food loss increases when the number of served alternatives increase	Serving waste	Changed from 3 to 2 menu options	All schools
Serving less "popular" dishes gave a rise to more food waste	Plate waste	Serve more "popular" dishes	Not implemented
Food waste reduced by informing students that food waste quantification weeks are in progress	Serving and plate waste	Informe students when food waste quantifications will be done	All schools
Food waste reduces by more flexible menus – leftovers could be served as regular alternatives	Serving waste	Reuse leftovers	All schools
Less plate waste loss in smaller dining halls	Plate waste	Create smaller dining halls	Not implemented

Since this study, new production kitchens are opened at two school catering units in Sala in 2018 and 2019. In addition, all school catering units changed from three to two menu options, students are informed about the food waste quantifications at their school and kitchens are encouraged to reuse their leftovers more (Boström, 2020). The proposed intervention "Serving more "popular" dishes" was not implemented, because that would limit the menu planning and leads to less variation, which can cause conflict with the Swedish meal model (Livsmedelsverket, 2020e). The proposed intervention "Create smaller dining halls" was not introduced, because it is expensive to rebuild already existing infrastructure. Besides, smaller dining halls would lead to longer school lunches.

2.5. Policy for food waste reduction

To give guidance to relevant stakeholders in the food chain, clear national, regional and local goals, strategies and practices should be put into place (Livsmedelsverket et al., 2018; Naturvårdsverket, 2020c; UNEP, 2014). Currently, Sala is working on a new Environmental Program for their municipality (Sala Kommun, 2020a). The Environmental program will display the municipality's environmental objectives and shows which goals they set to work towards long-term environmentally sustainable development from a local, regional, national as well as global perspective (Sala Kommun, 2020a). A goal for reducing food waste in the municipality's public catering units will also be included in the report. The current goal is:

> "50% of the food waste in public kitchens has to be reduced from 2021 to 2030"

Sala municipality has a total of 29 public catering units of which 11 are preschool kitchens, 13 are primary school kitchens, 2 are upper secondary school kitchens and 3 are kitchens serving elderly homes. Therefore, to reach the environmental objective the municipality needs to find out what the main causes are of food waste in their public kitchens and implement new measures to solve these problems.

In Sweden, food production and consumption have caused about half of the total eutrophication and 20 to 25% of the total climate impact (Naturvårdsverket, 2020b). Therefore, reducing food waste is an important point on the national environmental agenda. In 2020, the Swedish Environmental Protection Agency (Naturvårdsverket) released a document in which they propose a new national goal for reducing food waste. This milestone was based on national goals, European legislations and Agenda 2030 target 12.3 (Naturvårdsverket, 2020a). The currently proposed milestone for reducing food waste is:

> "The total food waste, in weight per capita, must be reduced by at least 20% from 2020 to 2025" (Naturvårdsverket, 2020a).

This milestone is made to provide a driving force for implementing measures and contribute to behavioural changes throughout the whole food chain. Moreover, the milestone should contribute to one uniform definition, measurability, follow-up, and motivate a joint responsibility in the food chain for the food losses that arise (Naturvårdsverket, 2020a).

In Sweden, food waste is looked upon as the responsibility of the municipality (Riksdagsförvaltningen, 2011; Stenmarck et al., 2011). The municipality is responsible for collecting, transporting and processing all the food waste that is generated. How strictly this is interpreted varies between the municipalities.

3. Method and materials

3.1. Area of study

In the autumn term of 2020, four food waste reduction interventions were introduced at school catering units in Sala municipality. The introduced interventions were, (1) “tasting spoon”, (2) “plate waste tracker”, (3) “awareness campaign” and (4) “demand forecasting”. These four interventions were selected because they specifically target the reduction of plate waste or serving waste and are easy to implement. Every food waste reduction intervention was introduced in at least two school canteens. In total eight school catering units were part of the experimental group and four school canteens were selected as a control group. Table 4 shows an overview of the twelve school canteens that were part of this study. The selection of schools was done in consultation with one of the public catering managers at Sala municipality.

Table 4. Studied school catering units (Sala Kommun, 2020b; Skolverket, 2019).

	Catering units	**Amount of students**	**Age range students**	**Location**	**Intervention**
1	S1	0 [1]	6-12	City	Tasting spoon
2	S2	759	6-15	City	Tasting spoon & Plate waste tracker
3	S3	191	6-12	City	Plate waste tracker
4	S4	118	6-12	Rural	Plate waste tracker
5	S5	309	6-12	City	Awareness campaign
6	S6	215	15-19	Rural	Awareness campaign
7	S7	445	15-19	City	Demand forecasting
8	S8	222	6-12	City	Demand forecasting
9	S9	64	6-9	Rural	Control group
10	S10	81	6-12	Rural	Control group
11	S11	75	6-12	Rural	Control group
12	S12	95	6-12	Rural	Control group

[1] Since autumn 2018, S1 has been evacuated due to moisture damage and all students were moved to S5. However, S1’s catering unit is still used to provide lunch for about half of S5’s students.

3.2. Selected interventions to reduce food waste

3.2.1. Tasting spoon

The intervention “tasting spoon” was selected for this study because, it has been used with good results on several other schools in Sweden (Andersson, 2020; Berisha and Wigen, 2018; Björklund, 2014). Previous case studies have shown that the tasting spoons managed to stop several students form scooping up food that they may not have eaten. At the same time, tasting spoons made some students discover that they actually like food that they did not think they liked before (Andersson, 2020). The tasting spoon is an intervention that is focused on reducing plate waste. Therefore the hypothesis for introducing this intervention is:

- Introducing the intervention *“tasting spoon”* leads to a decrease in *plate waste* compared to previous years.

In the school catering units where the intervention “tasting spoon” was introduced several trays with disposable tasting spoons were placed on top of the serving stations during lunchtime (Figure 5). If the student was unsure if they would like the meal or not they had the opportunity to use the tasting spoon to taste a little bit (one bite) of the meal to assess whether they liked the food or not. The idea of introducing tasting spoons is to prevent students from taking food they do not like and wasting it because of that.

Figure 5. Intervention “tasting spoon” (smaksked).

3.2.2. Plate waste tracker

The intervention “plate waste tracker” was selected for this study because it makes students more aware of the amount of food they waste and what the impact of this waste is. Increasing awareness and education on food waste on schools can have a great influence on the students. Making students more conscious regarding their food waste can encourage them to waste less food (Derqui et al., 2018; Whitehair

et al., 2013). Previous studies have shown that awareness and educational campaigns can lead to a reduction in plate waste in buffet catering (Kim and Freedman, 2010; Pinto et al., 2018). The plate waste tracker is an intervention that is focused on reducing plate waste. Therefore the hypothesis for introducing this intervention is:

- Introducing the intervention *"plate waste tracker"* leads to a decrease in *plate waste* compared to previous years.

In the school catering units where the intervention "plate waste tracker" was introduced a scale was placed underneath the food waste bin. This scale was connected to a tablet or touchscreen that gave students direct information about the average daily food waste and commented on the food they discarded in a written message and a coloured box depending on how much was wasted (Figure 6). The plate waste tracker also served as a communicational tool for the students to interact with and allowed them to give feedback on why they discarded food. The predefined answers were: "I did not like it/it was not my taste", "I took too much food" and "I did not have time to finish my meal".

Figure 6. Intervention "plate waste tracker" (Matomatic, 2020).

3.2.3. Awareness campaign

The selection of the intervention "awareness campaign" was based on more or less the same reasons as for introducing the intervention "plate waste tracker". The intervention awareness campaign was focused on making students more aware of food waste in general and that they should try to waste as little as possible. However, the differences between the two interventions are that the intervention

"awareness campaign" is a cheaper option and a one-way communicational tool compared to the intervention plate waste tracker. An awareness campaign is an intervention that is focused on reducing plate waste. Therefore the hypothesis for introducing this intervention is:

- Introducing the intervention *"awareness campaign"* leads to a decrease in *plate waste* compared to previous years.

In the school catering units where the intervention "awareness campaign" was introduced, table talkers were placed on the tables and the top of the serving stations (Figure 7). On these table talkers phrases like "Eat as much as you can – but throw away as little as you can" were displayed. The table talkers also encouraged students to take several times small portions and if they are unsure of a dish to first taste a little bit.

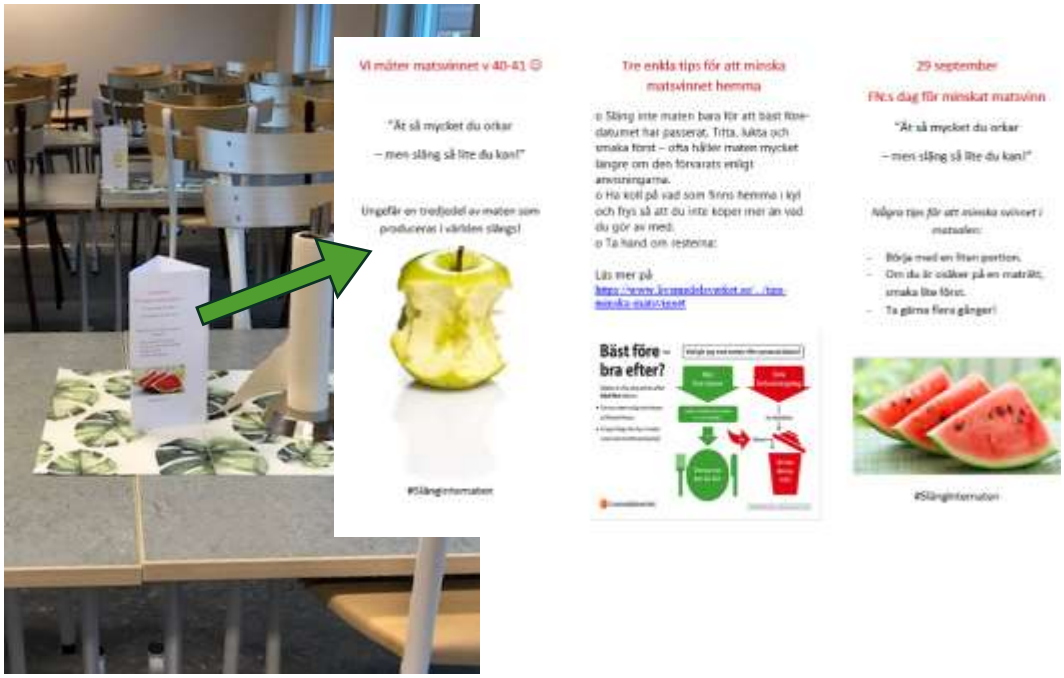

Figure 7. Intervention "awareness campaign".

3.2.4. Demand forecasting

The intervention "demand forecasting" was selected for this study because it is a tool to give businesses a more certain insight into future demands. This is important for a business because uncertainty in demand can result in two types of problems, overstocking and understocking (Agnew and Thornes, 2007). In the public catering sector, uncertainty due to overstocking can lead to insufficient use of shelf space and wastage of food, cost and resources. Uncertainty due to understocking can lead to stock-outs, negative reactions of guests and a bad image (Ivanov et al., 2019; Nari Sivanandam Arunraj et al., 2014). The knowledge of how many guests will

turn up during lunch is often embedded within kitchen staff with many years of experience but can be difficult to acquire for newcomers (Malefors et al., 2021). Thereby, even experienced staff can still have problems with changes in expected numbers of guests (Malefors et al., 2021). In the case of school catering units, this can mean that due to sickness or if students decide to have lunch somewhere else, not all students that are enrolled will show up for lunch. Demand forecasting is an intervention that gives kitchen staff better insight into future demand, which can lead to a reduction in serving waste. Therefore the hypothesis for introducing this intervention is:

- Introducing the intervention *"demand forecasting"* leads to a decrease in *serving waste* compared to previous years.

The school catering units where the intervention "demand forecasting" was introduced received a daily forecast of the number of guests that will come for lunch. At the end of the week, the head chef received a forecast for the next week so he or she could take this into account while ordering ingredients for the next week. The forecast was based on guest attendance data from 2010 to 2019.

3.3. Data collection

This study was based on data collected from twelve school catering units in Sala municipality. First, data from previous (2014-2019) and most recent (2020) food waste quantifications were collected and analysed. This was done to assess the four hypotheses mentioned in the previous section. In addition, among the studied school catering units, a survey was conducted to verify the quantification results, assess if there is a correlation between the amount of waste per portion and the number of actions taken by the individual catering units studied to reduce food waste and identify potential areas of improvement for the studied catering units.

3.3.1. Food waste quantification

To achieve transparent food waste quantification, it is necessary to give a clear definition of all the different steps that are included in the food waste quantification process (Malefors et al., 2019). The definitions used in this study, are based on defined definitions from the Swedish National Food Agency (Livsmedelsverket, 2020c) and Eriksson (Eriksson et al., 2018). These definitions are displayed in Table 5.

Table 5. Used definitions in the food waste quantification process (Malefors et al., 2019).

	Definition
Kitchen waste	Food waste that occurs in the kitchen, during storage and cooking. (In this study only edible food waste included).
Serving waste	Food that is presented in the serving but is thrown away because it is not consumed.
Plate waste	Food on the guests' plate that is not eaten and thrown away. (May contain napkins and/or bones).
Served food	The amount of food that left the kitchen intended for consumption.
Portions	The recorded number of portions for a given lunch.
KPI	Key performance indicator.
Waste per portion (g)	Waste (kg) divided by the number of portions × 1000
Waste (%)	Waste (kg) divided by served food (kg) × 100

Figure 8 puts the different definitions in Table 5 in context and shows where the different categories of waste occur in the kitchens during the process from receiving food until consumption.

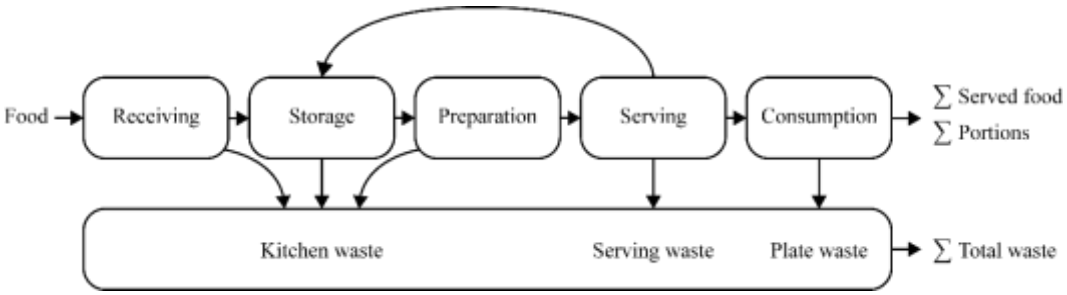

Figure 8. The process and the associated waste generating processes within a kitchen. Based on figure1 from Malefors et al.,2019.

Since the spring term of 2014, food waste quantifications are conducted at the different public catering units in Sala Municipality. Since then, most of Sala's public catering units quantified food waste, with a range from four till twenty-two days every term. Thus, the terms that were included in this study are from the spring term of 2014 till the autumn term of 2020. In this study, food waste quantification data was only included if it consisted of *serving waste*, *plate waste,* and the number of *portions*. When any of these indicators or processes were missing, the quantification for a given day was not included in the assessment. Every school had some terms where they did not do food waste quantifications, which lead to data gaps. Table 6 shows, which quantification periods are included for the different schools that are part of this study.

Table 6. Overview per term when the studied schools did food waste quantifications. Divided in spring term (ST) and autumn term (AT) every year. The symbol × indicates that food waste quantifications were conducted in that specific term.

Catering units	**ST14**	**AT14**	**ST15**	**AT15**	**ST16**	**AT16**	**ST17**	**AT17**	**ST18**	**AT18**	**ST19**	**AT19**	**ST20**	**AT20**
S1	×			×	×	×	×	×			×			×
S2		×	×	×	×	×	×	×			×			×
S3	×		×	×	×	×	×	×			×			×
S4		×	×	×	×	×	×	×			×			×
S5											×			×
S6		×	×	×	×	×	×	×			×			×
S7	×	×	×	×	×	×	×	×			×			×
S8			×	×	×	×	×	×			×			×
S9	×		×	×	×	×					×			×
S10	×	×	×	×	×	×	×	×			×			×
S11	×		×	×	×	×	×	×			×			×
S12	×	×	×	×	×	×	×	×			×			×

All the food waste quantifications performed by the school kitchens involved weighing waste masses using kitchen scales. The results of the food waste quantification were documented in a web application from Matomatic AB. The data collection was performed by the kitchen staff and sent to the overarching management (Sala municipality), who did further compilations and analysis on the data. All data were transformed into a standard format suggested by Malefors et al. (2019). This standard format is showed in table 7.

Table 7. Format used for extraction, transformation, and loading of food-waste quantification data from the participating schools (Malefors et al., 2019).

Variable	Definition	Type of data
Catering unit	Catering unit where the data came from	Text
Date	Date of quantification	Date format DD-MM-YYYY
Kitchen waste	Quantified mass of the kitchen waste	kg
Serving waste	Quantified mass of the serving waste	kg
Plate waste	Quantified mass of the plate waste	kg
Served food	Quantified mass of the served food	kg
Portions	Recorded portions for a given lunch	Number

To be able to compare the data from the different terms and the different catering units it is important to express the outcomes in similar key performance indicators (KPIs) (Malefors et al., 2019). For this study, the KPIs "Waster per portion (g)" and "Waste (%) served food" were chosen. The calculation of these two KPIs is as follows:

Calculation of "Waste per Portion (g)"

To calculate the KPI Waste per portion (g) per school per term, the total waste (kg) was divided by the number of portion served and multiplied by thousand. Equation (1) shows how this calculation was done. Here *i* represents a daily measurement and *n* the total number of quantification days in each school:

$$WPP\ (g) = \frac{\sum_{i=1}^{n}(Total\ waste\ (kg))_i}{\sum_{i=1}^{n}(Number\ of\ portions\ served\ )_i} \times 1000 \quad (1)$$

Calculation of "Waste (%) of Served Food"

To calculate the KPI "Waste (%) of served food" per school per term, the total waste (kg) was divided by the mass of served food (kg) and multiplied by hundred. Equation (2) shows how this calculation was done. Here *i* represents a daily measurement and *n* the total number of quantification days in each school:

$$Waste\ (\%) = \frac{\sum_{i=1}^{n}(Total\ waste\ (kg))_i}{\sum_{i=1}^{n}(Mass\ of\ served\ food\ (kg))_i} \times 100 \quad (2)$$

Confidence interval

In this study, the analysed quantification data were used to calculate the average amount of food waste per catering unit, per term and according to the waste per portion indicator. This average was based on several days or weeks every term. However, all average calculations are subject to variation. To visualize the uncertainty surrounding the average a 95% confidence interval according to the t-distribution was calculated. By calculating this, there is a 95% probability that the confidence interval will contain the true average. In this study, the confidence interval gave information about the precision regarding the average waste per portion. Equation 3 shows how to calculate the confidence interval Iμ.

$$I_\mu = \left(\bar{x} \pm t_\alpha \left(\frac{\sigma}{\sqrt{n}} \right) \right) \quad (3)$$

I_μ = confidence interval
$\bar{x}$ = sample average (mean)
t_α = confidence level value
σ = sample standard deviation
n = sample size

3.3.2. Survey

To get a general overview of the different catering units and identify which actions they currently use to reduce food waste, a survey was sent to the head chefs of the participating catering units. The survey was written in Swedish because all head chefs were Swedish speaking and it consisted of 3 open-ended questions and 53 close-ended questions (Appendix A).

General overview

In the survey, some general questions were asked to get an overview of the participating catering units. Three of these questions were asked to verify the head chefs' answers with the outcomes of the latest food waste quantification (AT2020). This was done to see if the head chefs' views are similar to reality. The questions were:

- How many guests do you have daily?
- How big are the portions you serve on average?
- Which waste category generates most of the food waste in your catering unit?

Actions taken

To get an insight on which actions the participating catering units currently take to reduce food waste, 50 statements (Appendix B) were presented to the head chefs of the participating catering units. Every head chef was asked to answer on which level they agree with the statement. Answers were scored on a 4-point Likert scale, with the levels; "Totally agree", "Somewhat agree", "Somewhat disagree" and "Disagree". To normalize the answers given by the head chefs every level got a point from 3 to 0 (Table 8).

Table 8. Points per level.

Level	Point
Totally agree	3
Somewhat agree	2
Somewhat disagree	1
Disagree	0

The 50 statements represented suggested actions to take to reduce food waste in a public catering unit. Of these actions, 45 were selected from the action list listed in the National Food Administrations' "Handbook for reducing food waste" (Livsmedelsverket, 2020b) and 5 were selected from the actions listed in Rainer's study who looked at food waste reduction strategies suggested in literature (Rainer, 2019). The 50 actions were divided into four categories, based on where they can help to reduce food waste: (1) Quantification and follow up, (2) Kitchen waste, (3) Serving waste, (4) Plate waste (Appendix B).

The answers on the statements were used to calculate how many actions (in percentage) the head chefs say they take to reduce food waste in their catering unit. Appendix C shows the answers to the statements per school catering unit. If the head chef would answer "totally agree" to all statements in one category, the maximum amount of points will be reached, which could be expressed in 100% use of the suggested actions. Table 9 shows the number of points per catering unit and the related percentage per category compared to the maximum amount per category.

Table 9. The number of points per school catering unit and the related percentage per category compared to the max amount per category.

	Max amount of points	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**
Quantification and follow up	**21**	9	6	8	10	9	7	14	12	13	7	10	10
	100%	*43%*	*29%*	*38%*	*48%*	*43%*	*33%*	*67%*	*57%*	*62%*	*33%*	*48%*	*48%*
Kitchen waste	**60**	43	41	37	52	43	49	57	55	58	43	43	54
	100%	72%	68%	62%	87%	72%	82%	95%	92%	97%	72%	72%	90%
Serving waste	**57**	30	34	27	32	32	34	33	33	46	24	30	36
	100%	*53%*	*60%*	*47%*	*56%*	*56%*	*60%*	*58%*	*58%*	*81%*	*42%*	*53%*	*63%*
Plate waste	**12**	8	9	6	7	7	6	4	10	10	6	6	9
	100%	*67%*	*75%*	*50%*	*58%*	*58%*	*50%*	*33%*	*83%*	*83%*	*50%*	*50%*	*75%*
Total	**150**	90	90	78	101	91	96	108	110	127	80	89	109
	100%	*60%*	*60%*	*52%*	*67%*	*61%*	*64%*	*72%*	*73%*	*85%*	*53%*	*59%*	*73%*

Later in the result part, will these percentages be used to see if there is a correlation between the two variables: (1) number of actions taken per category and (2) the amount of waste per portion. The studied hypothesis would be:

- If, per category, the amount (percentage) of actions taken to reduce food waste increases, the amount of waste per portion (g) for that particular category will decrease and vice versa.

The studied relationship between the two variables can be called a negative relationship (Akoglu, 2018; Dancey and Reidy, 2007; Ramzai, 2020). A negative relationship means that when one variable increases the other will decrease and vice versa. To measure the strength of the relationship between these two variables the Pearson correlation coefficient was used. The outcome of a negative relationship ranges from 0 to -1 (Dancey and Reidy, 2007). Table 10 shows the interpretation of Pearson's correlation coefficient.

Table 10. Interpretation of the Pearson's correlation coefficient (Akoglu, 2018).

Correlation coefficient	**Degree of correlation**
– 1	Perfect
– 0.9	Strong
– 0.8	Strong
– 0.7	Strong
– 0.6	Moderate
– 0.5	Moderate
– 0.4	Moderate
– 0.3	Weak
– 0.2	Weak
– 0.1	Weak
0	Zero

4. Results

In this chapter, the results of previous (2014-2019) vs. most recent (AT2020) food waste quantifications are shown. The results of the quantifications are expressed in waste per portion and waste in (%) of served food. In this study, total-, serving- and plate waste per portion are used to indicate if there is a significant change in the amount of food waste at the studied catering units between the previous semesters and the latest quantification. With the help of the confidence interval the results can show that waste per portion *increased, stayed more or less the same* or *decreased* compared to the years before. The error bars in Figure 10, 12, 14, 16 and 18 illustrate the calculated confidence interval per result. If the error bars are overlapping it can be said that the waste per portion *stayed more or less the same*. If the error bars are not overlapping, it means that the waste per portion *increased* or *decreased*. Section 4.1.6. gives a summary on the results of the introduced interventions. In addition, this chapter shows the results of the conducted survey and gives answers if there is a correlation between the waste per portion and the number of actions taken to reduce food waste.

4.1. The interventions

The results of the food waste quantifications are divided per studied food waste reduction intervention and the control group.

4.1.1. Tasting spoon

The intervention “tasting spoon” was introduced at the catering units *S1* and *S2*. The *hypothesis* for introducing this intervention was that it would lead to a decrease in *plate waste* compared to previous years. Figure 9 shows the average amount of food waste per portion divided into the three different categories, kitchen waste, serving waste and plate waste for these catering units per term.

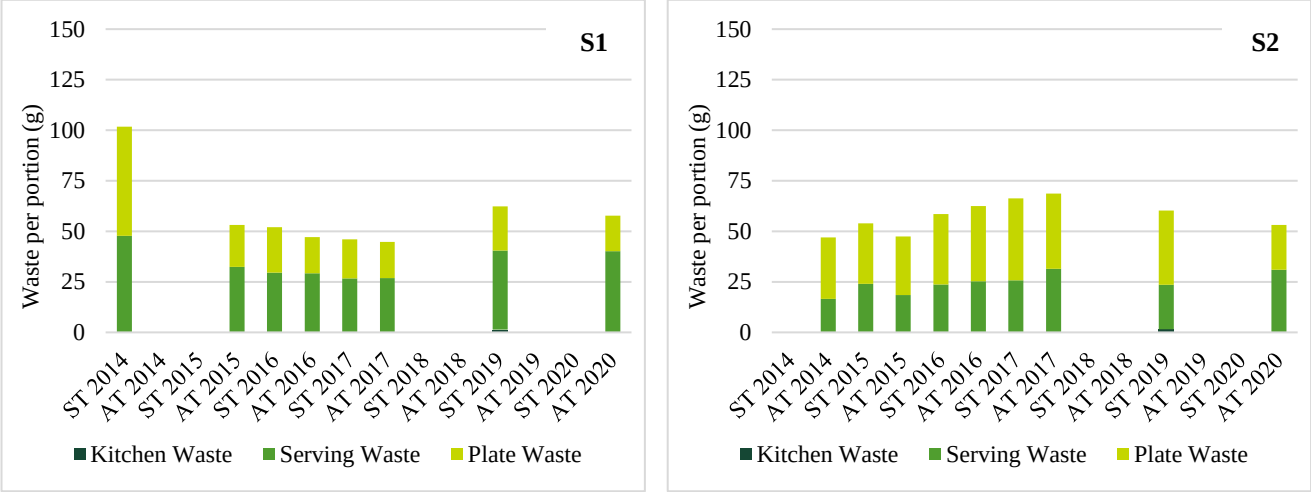

Figure 9. The total waste per portion divided into three different categories for the catering units that introduced the intervention “tasting spoon” per term.

Before introducing the intervention (2014-2019) at catering unit *S1*, the average waste per portion was 58g, which consisted of 33g serving waste and 25g plate waste. During this period, an average of 17% of the served food was wasted. After introducing the intervention (2020), the average waste per portion was 58g, which consisted of 40g serving waste and 18g and plate waste. During this period, an average of 18% of the served food was wasted, which is 1% more compared to the years before. During both periods, kitchen waste was not quantified or too small to show a result.

Before introducing the intervention (2014-2019) at catering unit *S2*, the average waste per portion was 58g, which consisted of 23g serving waste and 34g plate waste. During this period, an average of 16% of the served food was wasted. After introducing the intervention (2020), the average waste per portion was 53g, which consisted of 31g serving waste and 22g and plate waste. During this period, an average of 15% of the served food was wasted, which is 1% less compared to the years before. During both periods, kitchen waste was not quantified or too small to show a result.

Figure 10 shows the results, of the total, serving and plate waste per portion calculated for the catering units S1 and S2, before (2014-2019) and after (2020) introducing the intervention.

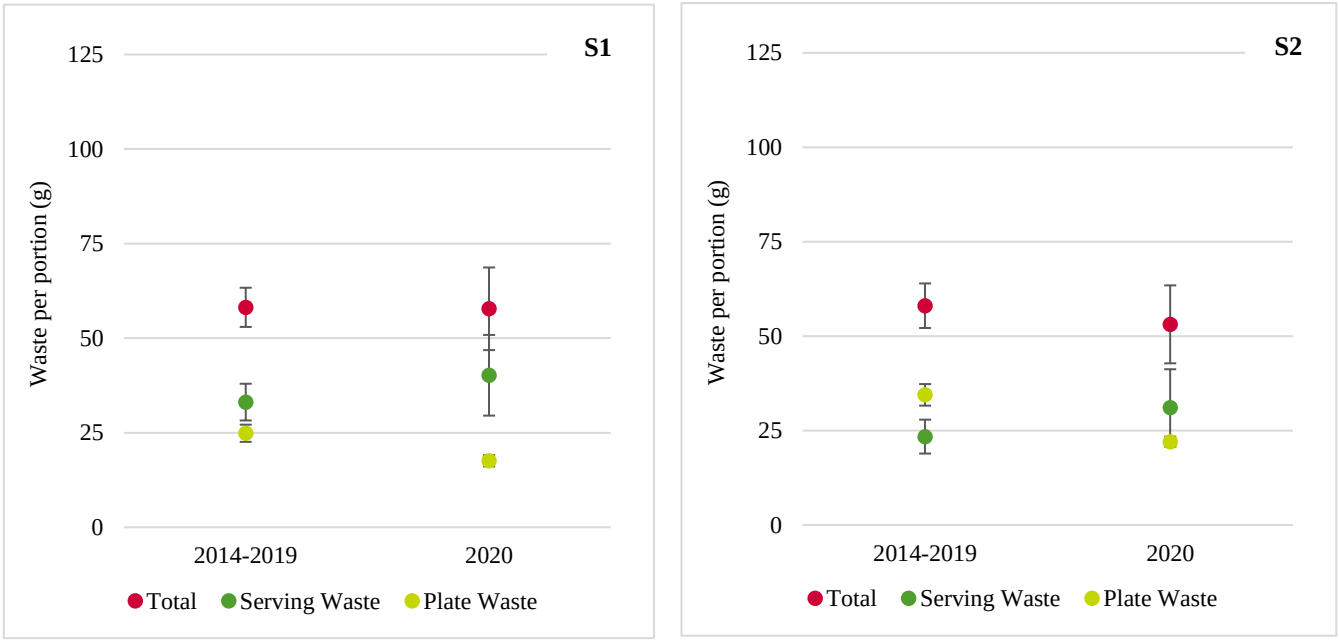

Figure 10. The total-, serving- and plate waste per portion, with a confidence interval (error bars), for the catering units that introduced the intervention "tasting spoon", before (2014-2019) and after (2020) introducing the intervention. Kitchen waste is left out due to small quantity.

After introducing the intervention "tasting spoon" at catering unit *S1*, the amount of *total*- and *serving* waste per portion stayed more or less the same and *plate* waste per portion decreased significantly.

After introducing the interventions "tasting spoon" and "plate waste tracker" at catering unit *S2*, the amount of *total*- and *serving* waste per portion stayed more or less the same and *plate* waste per portion decreased significantly.

This means that both catering units had a significant reduction of plate waste per portion which supports the hypothesis for introducing the intervention "tasting spoon".

4.1.2. Plate waste tracker

The intervention "plate waste tracker" was introduced at the catering units *S3* and *S4*. The *hypothesis* for introducing this intervention was that it would lead to a decrease in *plate waste* compared to previous years. Figure 11 shows the average amount of food waste per portion divided into the three different categories, kitchen waste, serving waste and plate waste for these catering units per term.

Figure 11. The total waste per portion divided into three different categories for the catering units that introduced the intervention "plate waste tracker" per term.

Before introducing the intervention (2014-2019) at catering unit *S3*, the average waste per portion was 85g, which consisted of 65g serving waste and 20g plate waste. Kitchen waste was not quantified or too small to show a result for this period. During this period, an average of 26% of the served food was wasted. After introducing the intervention (2020), the average waste per portion was 34g, which consisted of 3g kitchen waste, 21g serving waste and 10g and plate waste. During this period, an average of 14% of the served food was wasted, which is 12% less compared to the years before.

Before introducing the intervention (2014-2019) at catering unit *S4*, the average waste per portion was 83g, which consisted of 1g kitchen waste, 63g serving waste and 18g plate waste. During this period, an average of 25% of the served food was wasted. After introducing the intervention (2020), the average waste per portion was 57g, which consisted of 4g kitchen waste 31g serving waste and 22g and plate waste. During this period, the amount of served food was not quantified, which made it not possible to calculate the waste in (%) of served food.

Figure 12 shows the results, of the total, serving and plate waste per portion calculated for the catering units S3 and S4, before (2014-2019) and after (2020) introducing the intervention.

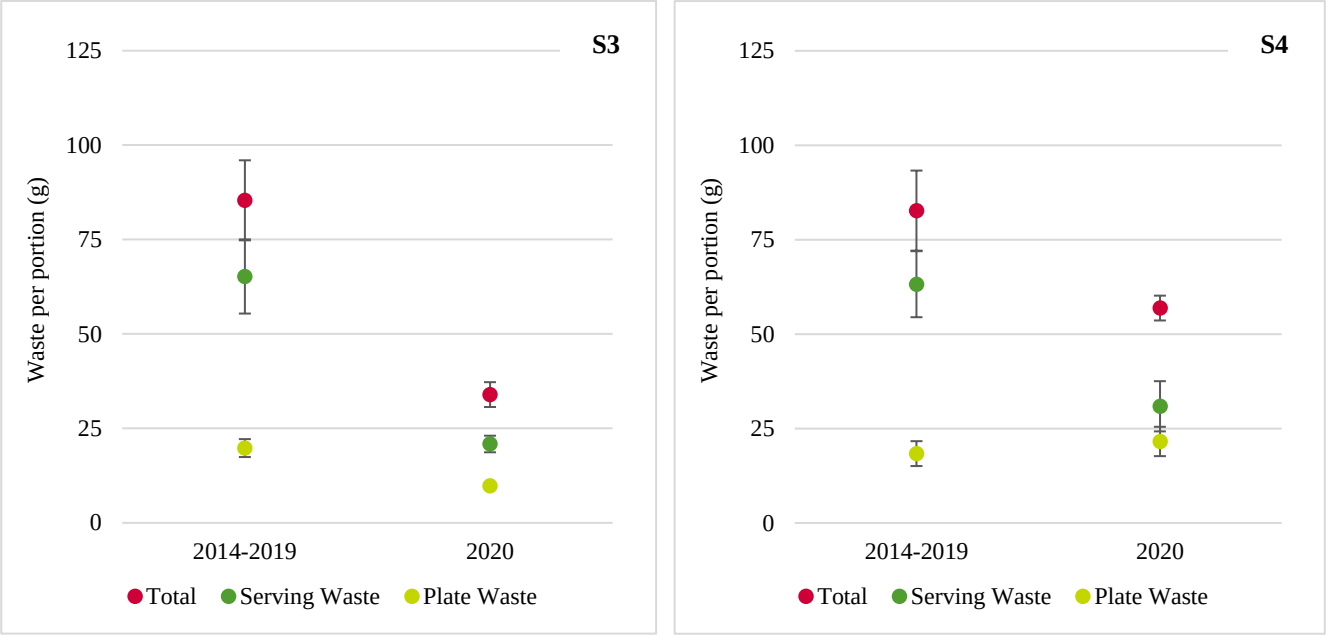

Figure 12. The total-, serving- and plate waste per portion, with a confidence interval (error bars), for the catering units that introduced the intervention "plate waste tracker", before (2014-2019) and after (2020) introducing the intervention. Kitchen waste is left out due to small quantity.

After introducing the intervention "plate waste tracker" at catering unit *S3*, the amount of *total-*, *serving-* and *plate* waste per portion decreased.

After introducing the intervention "plate waste tracker" at catering unit *S4*, the amount of *total-* and *serving* waste per portion decreased and *plate* waste per portion stayed more or less the same.

These results show that only catering unit *S3* had a significant reduction of plate waste per portion, which means that the hypothesis for introducing the intervention "plate waste tracker" is only confirmed by the results of catering unit *S3*. For catering unit *S4* the plate waste per portion stayed more or less the same.

4.1.3. Awareness campaign

The intervention "awareness campaign" was introduced at catering unit *S5* and *S6*. The *hypothesis* for introducing this intervention was that it would lead to a decrease in *plate waste* compared to previous years. Figure 13 shows the average amount of food waste per portion divided into the three different categories, kitchen waste, serving waste and plate waste for these catering units per term.

Figure 13. The total waste per portion divided into three different categories for the catering units that introduced the intervention "awareness campaign" per term.

Before introducing the intervention (2014-2019) at catering unit *S5*, the average waste per portion was 40g, which consisted of 24g serving waste and 16g plate waste. During this period, an average of 14% of the served food was wasted. After introducing the intervention (2020), the average waste per portion was 52g, which consisted of 42g serving waste and 10g and plate waste. During this period, an average of 15% of the served food was wasted, which is 1% more compared to the years before. During both periods, kitchen waste was not quantified or too small to show a result.

Before introducing the intervention (2014-2019) at catering unit *S6*, the average waste per portion was 103g, which consisted of 1g kitchen waste 63g serving waste and 39g plate waste. During this period, an average of 20% of the served food was wasted. After introducing the intervention (2020), the average waste per portion was 86g, which consisted of 5g kitchen waste 51g serving waste and 30g and plate waste. During this period, an average of 21% of the served food was wasted, which is 1% more compared to the years before.

Figure 14 shows the results, of the total, serving and plate waste per portion calculated for catering units S5 and S6, before (2014-2019) and after (2020) introducing the intervention.

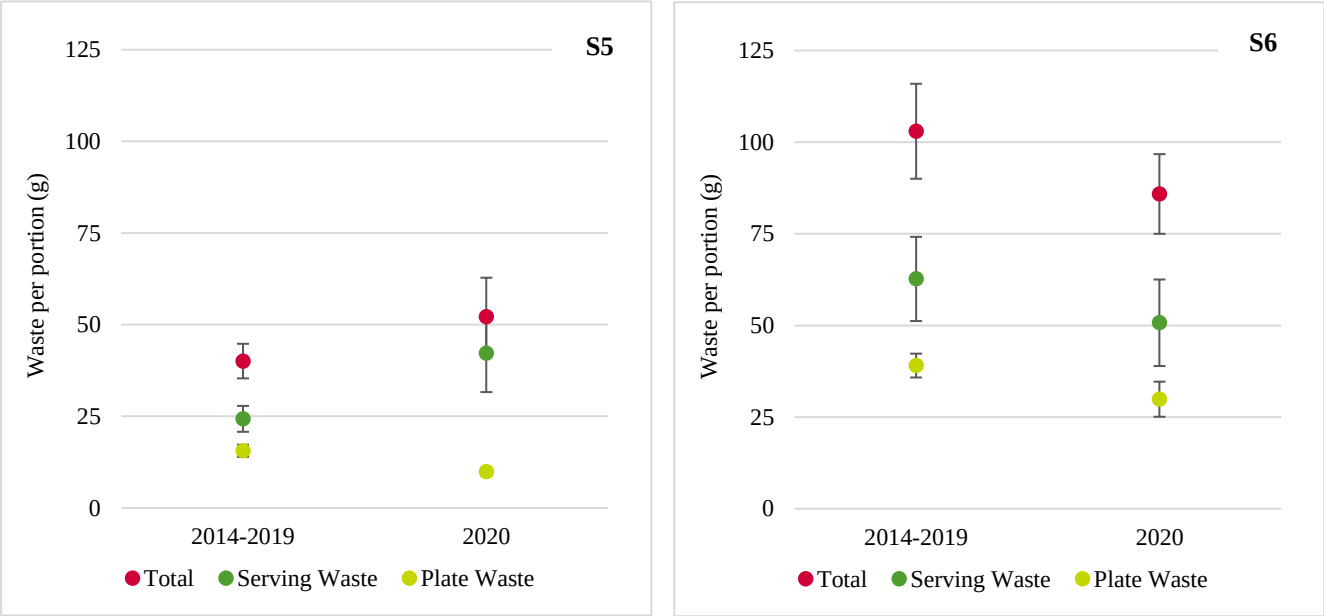

Figure 14. The total-, serving- and plate waste per portion, with a confidence interval (error bars), for the catering units that introduced the intervention "awareness campaign", before (2014-2019) and after (2020) introducing the intervention. Kitchen waste is left out due to small quantity.

After introducing the intervention "awareness campaign" at catering unit *S5*, the amount of *total* waste per portion stayed more or less the same, *serving* waste per portion increased and *plate* waste per portion decreased.

After introducing the intervention "awareness campaign" at catering unit *S6*, the amount of *total*- and *serving* waste per portion stayed more or less the same and *plate* waste per portion decreased.

This means that both catering units had a significant reduction of plate waste per portion which supports the hypothesis for introducing the intervention "awareness campaign".

4.1.4. Demand forecasting

The intervention "demand forecasting" was introduced at catering units *S7* and *S8*. The *hypothesis* for introducing this intervention was that it would lead to a decrease in *serving waste* compared to previous years. Figure 15 shows the average amount of food waste per portion divided into the three different categories, kitchen waste, serving waste and plate waste for these catering units per term.

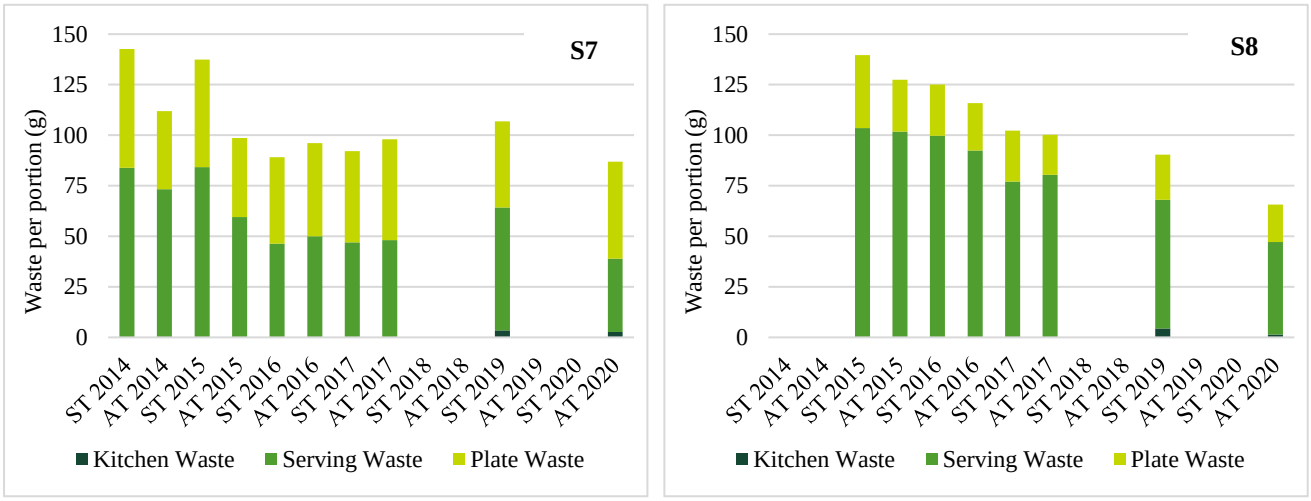

Figure 15. The total waste per portion divided into three different categories for the catering units that introduced the intervention "demand forecasting" per term.

Before introducing the intervention (2014-2019) at catering unit *S7*, the average waste per portion was 108g, which consisted of 61g serving waste and 46g plate waste. Kitchen waste was not quantified or too small to show a result for this period. During this period, an average of 25% of the served food was wasted. After introducing the intervention (2020), the average waste per portion was 87g, which consisted of 3g kitchen waste 36g serving waste and 48g and plate waste. During this period, an average of 17% of the served food was wasted, which is 8% less compared to the years before.

Before introducing the intervention (2014-2019) at catering unit *S8*, the average waste per portion was 114g, which consisted of 1kg kitchen waste, 88g serving waste and 25g plate waste. During this period, an average of 31% of the served food was wasted. After introducing the intervention (2020), the average waste per portion was 66g, which consisted of 1 kg kitchen waste, 46g serving waste and 19g and plate waste. During this period, an average of 24% of the served food was wasted, which is 7% less compared to the years before.

Figure 16 shows the results, of the total, serving and plate waste per portion calculated for the catering units S7 and S8, before (2014-2019) and after (2020) introducing the intervention.

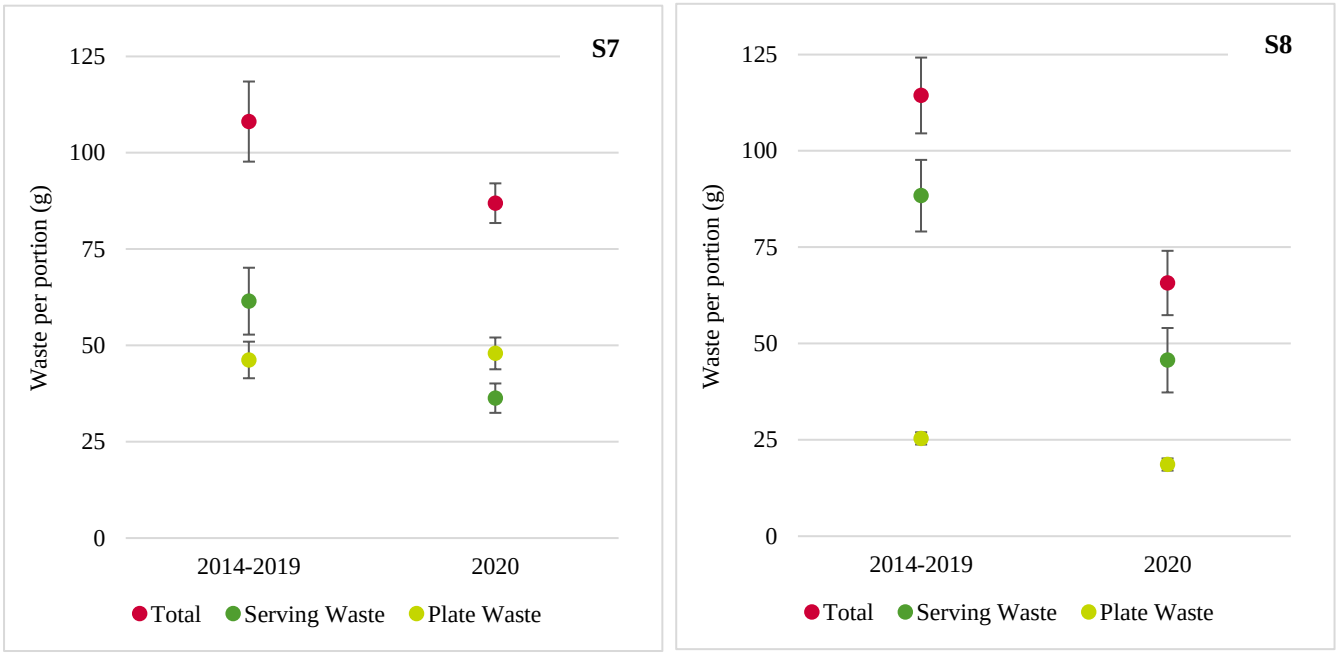

Figure 16. The total-, serving- and plate waste per portion, with a confidence interval (error bars), for the catering units that introduced the intervention "demand forecasting", before (2014-2019) and after (2020) introducing the intervention. Kitchen waste is left out due to small quantity.

After introducing the intervention "demand forecasting" at catering unit *S7*, the amount of *total*- and *serving* waste per portion decreased and *plate* waste per portion stayed more or less the same.

After introducing the interventions "demand forecasting" at catering unit *S8*, the amount of the *total*-, *serving*- and *plate* waste per portion decreased.

This means that both catering units had a significant reduction of serving waste per portion which supports the hypothesis for introducing the intervention "demand forecasting".

4.1.5. Control group

Catering units *S9, S10, S11* and *S12* were part of the control group. This means that no new food waste reduction interventions were introduced in 2020. Figure 17 shows the average amount of food waste per portion divided into the three different categories, kitchen waste, serving waste and plate waste for these catering units per term.

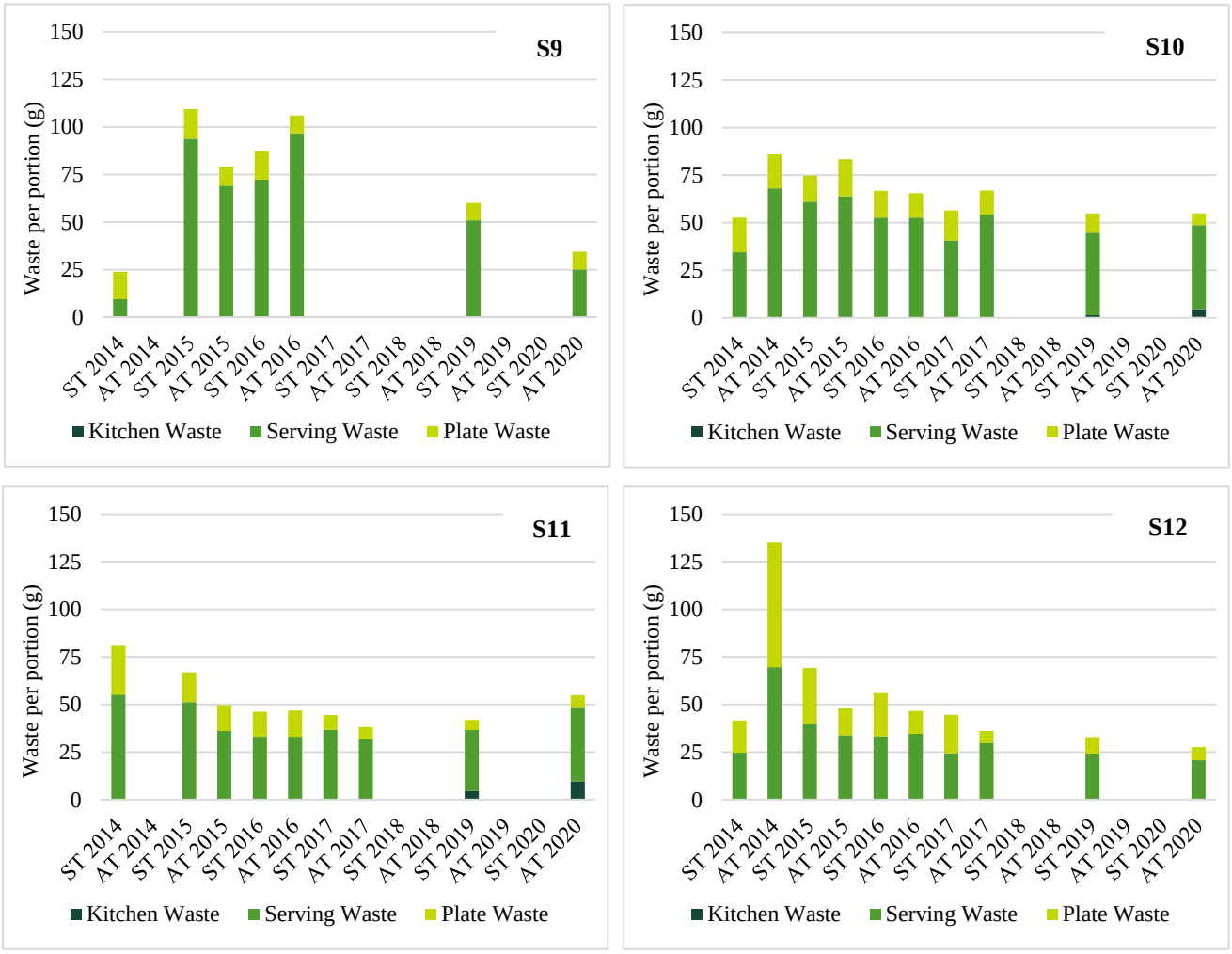

Figure 17. The total waste per portion divided into three different categories for the catering units in the control group per term.

In the period from 2014 till 2019, catering unit *S9* had an average waste per portion of 78g, which consisted of 65g serving waste and 12g plate waste. During this period, an average of 23% of the served food was wasted. In 2020, the average waste per portion was 35g, which consisted of 25g serving waste and 9g and plate waste. During this period, an average of 12% of the served food was wasted, which is 11% less compared to the years before. During both periods, kitchen waste was not quantified or too small to show a result.

In the period from 2014 till 2019, catering unit *S10* had an average waste per portion of 67g, which consisted of 52g serving waste and 15g plate waste. Kitchen waste was not quantified or too small to show a result for this period. During this period, an average of 18% of the served food was wasted. In 2020, the average waste per portion was 55g, which consisted of 5g kitchen waste, 44g serving waste and 6g and plate waste. During this period, an average of 16% of the served food was wasted, which is 2% less compared to the years before.

In the period from 2014 till 2019, catering unit *S11* had an average waste per portion of 52g, which consisted of 39g serving waste and 13g plate waste. During this period, an average of 15% of the served food was wasted. In 2020, the average waste per portion was 55g, which consisted of 10g kitchen waste, 39g serving waste and 6g and plate waste. During this period, an average of 15% of the served food was wasted, which is similar to the years before.

In the period from 2014 till 2019, catering unit *S12* had an average waste per portion of 57g, which consisted of 1g kitchen waste, 35g serving waste and 22g plate waste. During this period, an average of 15% of the served food was wasted. In 2020, the average waste per portion was 28g, which consisted of 21g serving waste and 7g and plate waste. During this period, an average of 9% of the served food was wasted, which is 6% less compared to the years before. During both periods, kitchen waste was not quantified or too small to show a result.

Figure 18 shows the results, of the total, serving and plate waste per portion calculated for the catering units S9, S10, S11 and S12 in the time period 2014-2019 and 2020.

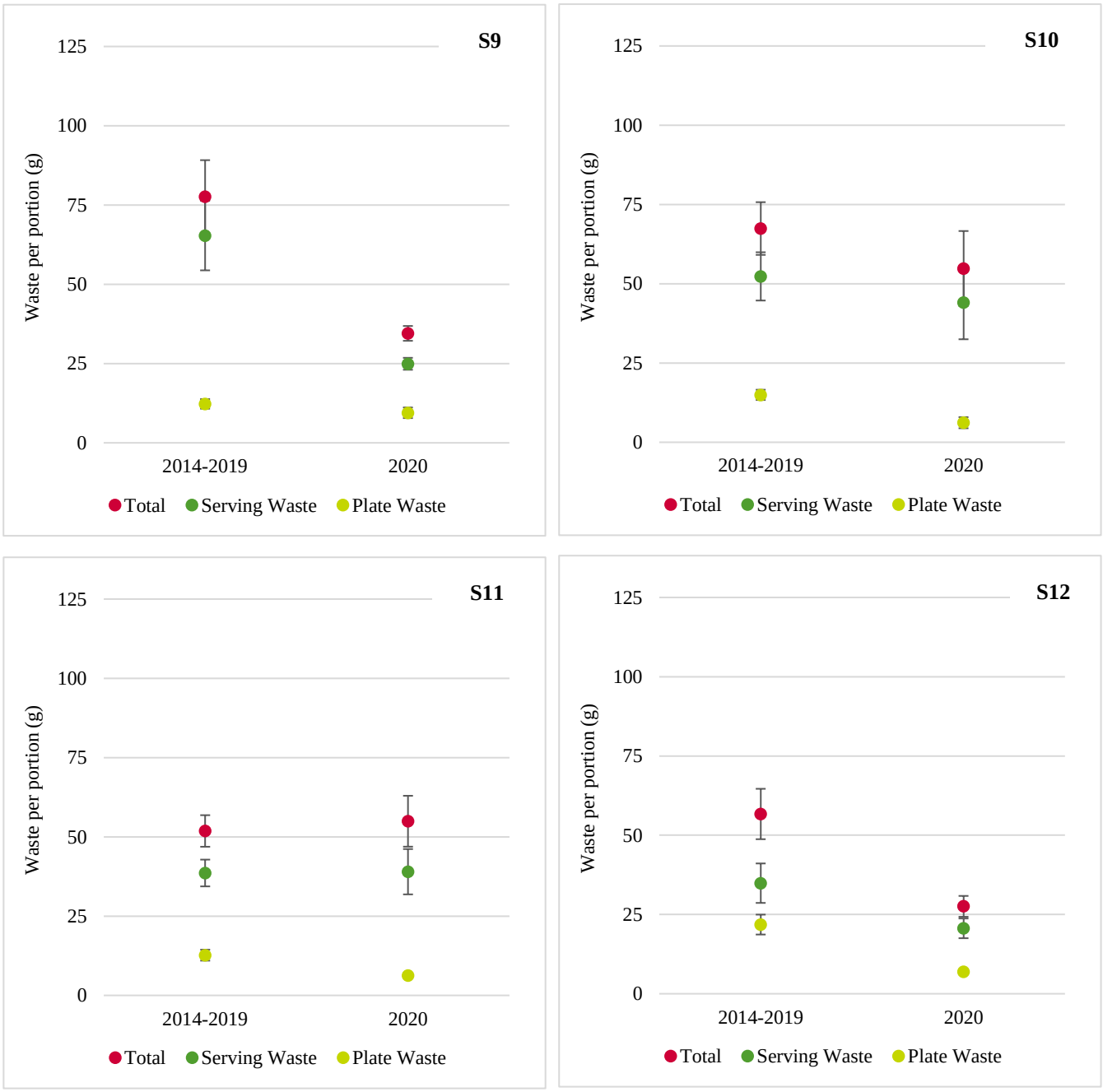

Figure 18. The total-, serving- and plate waste per portion, with a confidence interval (error bars), for the catering units in the control group, in the time period 2014-2019 and 2020. Kitchen waste is left out due to small quantity.

In 2020, at catering unit S9, the amount of *total*- and *serving* waste per portion decreased and *plate* waste per portion stayed more or less the same compared to the years before (2014-2019).

In 2020, at catering unit S10, the amount of *total*- and *serving* waste per portion stayed more or less the same and *plate* waste per portion decreased compared to the years before (2014-2019).

In 2020, at catering unit S11, the amount of *total-* and *serving* waste per portion stayed more or less the same and *plate* waste per portion decreased compared to the years before (2014-2019).

In 2020, at catering unit S12, the amount of *total-, serving* and *plate* waste per portion decreased compared to the years before (2014-2019).

4.1.6. Summary

All results from the sections above are put together in table 11. This was done to get a clear overview of the outcomes of the different food waste reduction interventions and the control group and see if they fulfilled the hypotheses. Table 11 shows the results of the amount of food waste per waste category in the studied catering units compared to the years before. The three different figures in the table show if the amount of food waste in the latest food waste quantification (AT2020) increased (▲), stayed more or less the same (▬) or decrease (▼) compared to the years before. The green squares show where the hypotheses for the relevant intervention are supported. This indicates that seven of the eight catering units that were part of the experimental group support the hypotheses.

To get an idea of how much serving-, plate- and total food waste the participating catering units reduced in the latest quantification (AT2020) compared to the years before, the average reduction was calculated. Table 11 shows the average reduction per catering unit in the latest quantification compared to the years before. Table 11 indicates that for the reduction of *serving waste* catering units S3 and S8 shows the *highest* average reduction in the latest quantification compared to the years before. The *Lowest* average reduction of serving waste is shown by catering units S2 and S5. For the reduction of *plate waste* catering units S12 and S2 shows the *highest* average reduction in the latest quantification compared to the years before. The *Lowest* average reduction of plate waste is shown by catering units S4 and S7. And for the reduction of *total waste* catering units S3 and S8 shows the *highest* average reduction in the latest quantification compared to the years before. The *Lowest* average reduction of total waste is shown by catering units S5 and S11.

Table 11. Results of the amount of food waste per waste category and the average reduction (g/portion) in the studied catering units compared to the years before. Increase (▲) , more or less the same (▬) and decrease (▼). The green squares indicate where the hypotheses are supported.

	Tasting spoon		Plate waste tracker		Awareness campaign		Demand forecasting		Control group			
Catering units	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
Serving waste	▬	▬	▼	▼	▲	▬	▼	▼	▼	▬	▬	▼
Average reduction (g/portion)	7	8	-44	-32	18	-12	-23	-42	-40	-8	0	-14
Plate waste	▼	▼	▼	▬	▼	▼	▬	▼	▬	▼	▼	▼
Average reduction (g/portion)	-7	-12	-10	4	-6	-9	4	-6	-3	-9	-7	-15
Total waste	▬	▬	▼	▼	▬	▬	▼	▼	▼	▬	▬	▼
Average reduction (g/portion)	0	-5	-51	-26	12	-17	-16	-48	-43	-12	3	-29

4.2. Comparison answers head chefs vs. reality

In the survey, the head chefs of the participating catering units were asked to answer the questions “Which waste category generates most of the food waste in your catering unit?”, “How many guests do you have daily?” and “How big are the portions you serve on average?”. To verify the head chefs answers, the data of the most recent quantification (AT 2020) was used. Both the answers from the head chefs and the and the outcomes from the latest quantification (AT 2020) are displayed in table 12.

Table 12. Answers from the head chefs and the outcomes from the latest quantification (AT 2020).

	Answer head chef			Latest quantification (AT2020)		
	Most food waste	Number of guests daily	Average portion size (g)	Most food waste	Number of guests daily	Average portion size (g)
S1	Plate	170	201 - 300	Serving	215	258
S2	Plate	1100	201 - 300	Serving	1036	308
S3	Serving	240	201 - 300	Serving	214	218
S4	Serving	220	301 - 400	Serving	145	-
S5	Serving	130	201 - 300	Serving	139	288
S6	Plate	175	301 - 400	Serving	168	332
S7	Plate	360	100 - 200	Plate	336	410
S8	Plate	224	201 - 300	Serving	207	211
S9	Serving	96	<100	Serving	85	264
S10	Serving	82	don't know	Serving	81	288
S11	Serving	135	201 - 300	Serving	81	323
S12	Serving	140	201 - 300	Serving	128	294

Table 12 shows that five of the twelve head chefs from the participating catering units think most of their food waste is generated through plate waste. However, in reality, only catering unit S7 generates most of their food waste trough plate waste. The other eleven catering units, generate most of their food waste through serving waste. Most of the head chefs seem to have a good view of how many guests they have daily and what the average portion size is at their catering unit. The exemptions were: the head chefs from catering units S4 and S11 who estimated the number of guests daily 52% and 67% higher than in reality. Moreover, the head chefs at catering units S7, S9 and S10 had a really low estimate on the average portion size or did not know how big the average portion size could be.

4.3. Correlation between the number of actions taken and the waste per portion

To see if there is a correlation between the number of actions taken (in percentage) and the waste per portion (g) the Pearson correlation coefficient was calculated. The number of actions taken was based on the answers given by the head chefs from the studied catering units on the 50 presented statements in the survey. The data for the amount of serving, plate and total waste per portion was collected from the latest food waste quantification available (AT2020).

Figure 19 shows the correlation between how many actions are taken and the serving waste per portion for the twelve studied catering units. In this case, the

calculated correlation coefficient had a value of -0.3. This means that there is a *weak* correlation between how many measures are used and the serving waste per portion (Table 10).

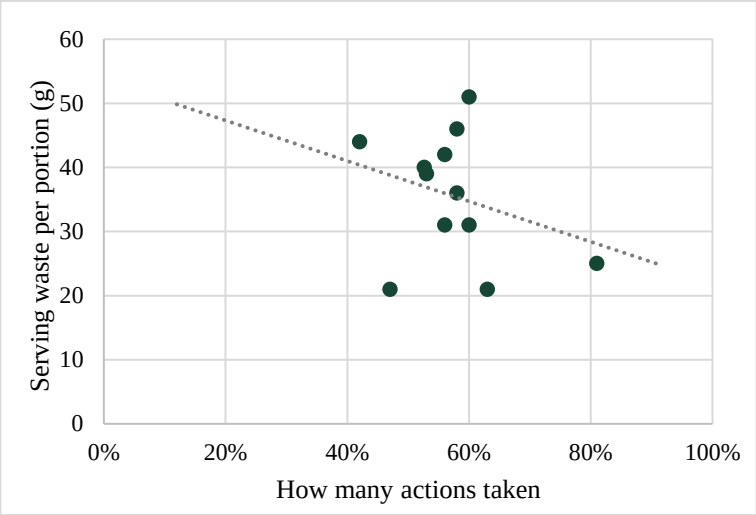

Figure 19. The correlation between how many actions are taken and the serving waste per portion (g).

Figure 20 shows the correlation between how many actions are taken and the plate waste per portion for the twelve studied catering units. In this case, the calculated correlation coefficient had a value of -0.4. This means that there is a *moderate* correlation between how many measures are used and the plate waste per portion (Table 10).

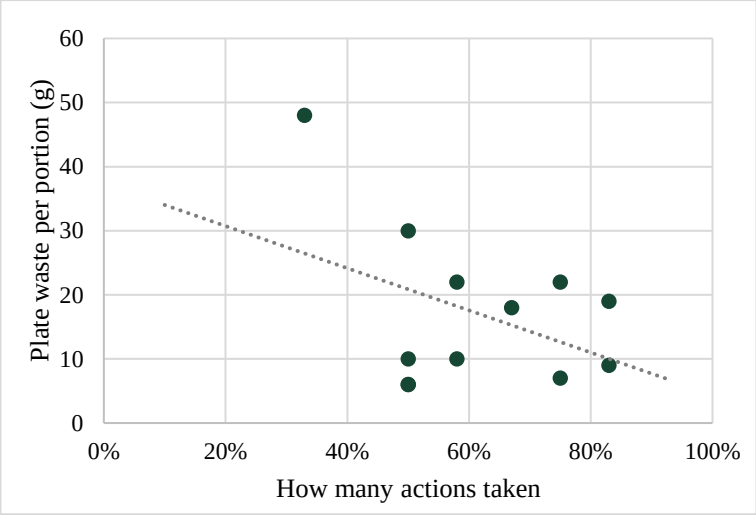

Figure 20. The correlation between how many actions are taken and the plate waste per portion (g).

Figure 21 shows the correlation between how many actions are taken and the total waste per portion for the twelve studied catering units. In this case, the calculated

correlation coefficient had a value of -0.0. This means that there is *no* correlation between how many measures are used and the total waste per portion (Table 10).

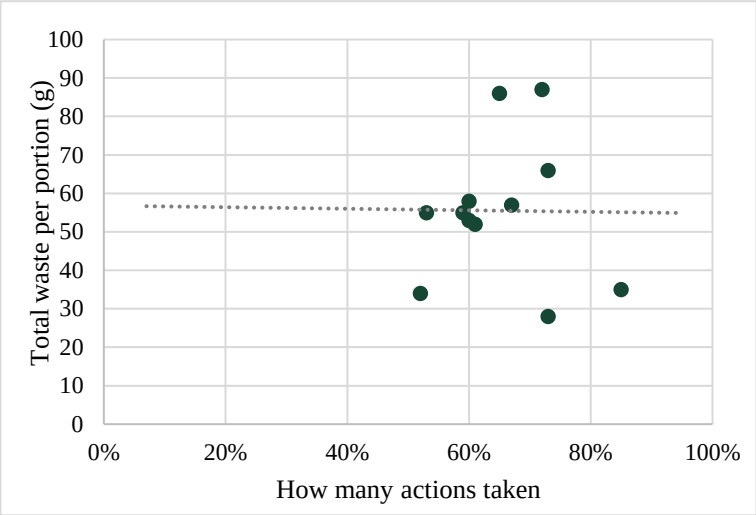

Figure 21. The correlation between how many actions are taken and the total waste per portion (g).

Looking at the answers given on the 50 statements presented to the head chefs from the participating catering units, positive and negative trends can be identified for some of the suggested actions (Appendix C). A positive trend that can be identified, is that all studied catering units quantify the food waste they generate regularly and show the results to their staff. Moreover, most of the catering units take a lot of action to reduce kitchen waste. For example, before purchasing new stock they check and use their current stock and they work according to the principle "first in – first out". A negative trend that can be identified is that most of the catering units do not have specific guidelines or a goal set for how much and when to reduce food waste. Moreover, at all catering units, staff and/or pupils are not allowed to take (or buy) leftovers and most catering units indicate that they do not have proper funding to reduce food waste. Besides, pupils are not really involved in the menu planning and it seems like the kitchen staff does not give feedback to the recipe manager if they think that the portions are too big or too small for the pupils.

5. Discussion

5.1. Limitations

When reading this thesis one should keep in mind that this is only a small representation of reality. With twelve catering units studied in one municipality, the results are foremost applicable to the catering units participating in this study. Every catering unit has its challenges and the introduction of an intervention to reduce food waste will likely have different effects. However, the results are interesting for any catering unit that is interested in using interventions to reduce their food waste. Based on the results, other catering units, that have a system for quantifying their food waste in place, can decide to introduce one of the studied interventions or see how they could study the effect of introducing another intervention.

This study first planned to also do observations at the participating catering units. However, after September 2020 all visits to the participating catering units were cancelled due to the second corona outbreak. This made that this study is mainly based on quantitative data. Adding qualitative data to this study could serve as a good method to control the head chefs answers to the survey. Therefore, For further study, it would be good to do these observations to see if there are any big differences between the answers to the survey and how the catering units work in practice.

5.2. The interventions

This study aimed to assess the effect of food waste reduction interventions in public catering units and see if they have the desired reduction effect. The results indicate that seven of the eight school canteens, who were part of the experimental group, showed a significant reduction in the food waste category mentioned in the hypotheses. This means that seven of the eight catering units that were part of the experimental group support the hypotheses and therefore indicate that the food waste reduction interventions had the desired reduction effect. From the four food waste reduction interventions researched in this study, the intervention “demand

forecasting" seems to be the most successful to reduce food waste. This is because the catering units where the intervention "demand forecasting" was introduced showed the largest reduction effect when looking at the absolute reduction in the food waste category mentioned in the hypotheses. However, to fully assign the reduction in food waste to the introduction of the interventions would be too limited. For several years, Sala municipality has been looking at ways on how to reduce food waste in their municipality's catering units. They have made changes in their public catering units based on previous studies (Boström, 2020; Eriksson et al., 2016). For example, changing satellite kitchens to production kitchens, changing from three to two menu options and reuse their leftovers (Boström, 2020). Thereby, every school term, food waste quantification weeks are held on all catering units in Sala municipality. During these weeks the catering units are encouraged to perform better than before. In the autumn term, a price in the form of a golden plate is awarded to the school with the lowest amount of plate waste per portion (Boström, 2020). All this may contribute to the reduction of food waste in Sala's public catering units. This can explain why some catering units in the control group also showed a significant reduction in plate-, serving- and/or total waste per portion compared to the years before. None of the participating catering units showed an increase in their total food waste per portion, which can indicate that there is an overall trend that food waste stays more or less the same or decreases at the catering units in Sala municipality since they have the topic on the agenda.

The results also show, that from the experimental group, catering unit S2 had the greatest reduction in plate waste compared to the years before. Catering unit S2 was the only catering unit that introduced both the intervention "tasting spoon" and "plate waste tracker". Despite the introduction of two interventions, catering unit S2 did not show double the reduction. This may be due to a threshold effect. Meaning that if a catering takes all actions possibly manageable to take, it will eventually reach a plateau where it levels out and further reduction is not possible.

5.3. Answers head chefs vs. reality

When comparing the answers on the survey with the quantification results, two interesting results come up. The first result is that five of the twelve catering units studied answered that most of their food waste is created through plate waste. However, the quantification results show that in reality, only one catering unit creates most of their food waste through plate waste. The other eleven catering units create most of their food waste through serving waste. This misconception can cause catering units to focus on the wrong problem and introduce interventions that are not focused on the actual waste generating hotspot in their catering unit. In this way, they may miss the potential to reduce food waste in their catering unit.

The second result is that ten from the twelve catering units studied overestimate the number of guests they have daily. Two of these catering units overestimate the number of guests daily with 52% and 67%. Structural overestimation can lead to overstocking and overproduction. Overstocking and overproduction can lead to insufficient use of shelf space and wastage of food, cost and resources (Ivanov et al., 2019; Nari Sivanandam Arunraj et al., 2014). To give kitchen staff better insight into future demand interventions like ”demand forecasting” can be of good help.

5.4. Correlation between the number of actions taken and the waste per portion

The results indicate that there is no correlation between how many measures the participating catering units say they use and total waste per portion. This could be due to the fact that there is an imbalance in the number of actions listed per category where they can help to reduce food waste. Most of the action points used in this study were selected from the Swedish National Food Administrations' "Handbook for reducing food waste". The action list from the Swedish National Food Administration has a strong focus on reducing kitchen waste (24 actions) and serving waste (26 actions) (Livsmedelsverket, 2020b). For the categories "quantification and follow up" and "plate waste", only 6 actions are listed each. This opens up that maybe more suggestions in the handbook should cover plate waste since this is a far greater problem than for example kitchen waste.

When more specific looking at the correlation between how many measures a catering unit say they use to reduce serving waste or plate waste, a weak or moderate correlation occurs. These results indicate that the use of actions and interventions to address a specific food category seem to help to reduce food waste in these categories. However, when analysing these results it is good to keep in mind that all actions in this study were generalized and compared at the same level. Yet, some actions may have a greater or lesser reduction effect than others. Besides, the Likert scale was used as a method in the survey to get a result on how many measures the participating catering units say they use. Likert scales have the advantage that they do not expect a simple yes or no answer from the respondent, but rather allow for degrees of opinion. In this way, quantitative data is obtained, which means that the data can be analysed relatively easy. However, Likert-type questions may lead to social desirability bias (Baron, 1996). Respondents often avoid selecting the extreme answers or disagreeing with statements to look more "normal" or show themselves in a favourable light. This all may have contributed to the relatively low values in correlation. A more balanced action list and including

control questions to verify the respondents' answers could help to improve this method and may lead to different outcomes in the correlation.

5.5. Reaching the goal

Sala municipality has set the goal to reduce 50% of the food waste in their public catering units from 2021 to 2030. This goal is in line with SDG target 12.3 that calls for halving per capita global food waste at retail and consumer levels and reducing food loss along production and supply chains, including post-harvest losses, by 2030 (FAO, 2019; UN, 2015).

The average total food waste per portion from the studied catering units (the twelve catering units) measured during the latest quantifications is 55g food waste per portion. A 50% reduction of food waste in the public catering units would mean that all kitchens should aim to work towards circa 28g food waste per portion. At the moment, only one of the twelve catering units meets this goal. To meet this goal, the other catering units need to reduce their current waste per portion between 19% and 68%. The fact that one catering unit already meets the goal shows that in theory, it is feasible. To reach this goal Sala municipality should continue the regular food waste quantifications to keep track of the food waste hotspots in their catering units and introduce interventions based on the identified problems. In this way, the kitchen staff does not have to guess where in their process they think they generate most of their food waste. This study indicates that, currently, most of the participating catering units waste most food during serving. Therefore, Sala municipality should put a higher emphasis on introducing interventions that focus on the reduction of serving waste, such as demand forecasting and reuse leftovers.

This study confirms that the public catering sector still has a lot to gain when it comes to reducing food waste. To improve food security, contribute towards environmental sustainability, reduce production cost and make food systems more efficient every intervention that helps to reduce food waste is a step in the right direction.

6. Conclusion

This study aimed to assess the effect of food waste reduction interventions in public catering units and see if they have the desired reduction effect. In this study, the four interventions “tasting spoon”, “plate waste tracker”, “awareness campaign” and “demand forecasting” were assessed. The results indicate that seven of the eight public catering units where an intervention was introduced, had the desired reduction effect. Based on the absolute desired reduction in food waste, the intervention “demand forecasting” seems to be the most successful to reduce food waste. However, when looking at these results one should keep in mind that there may be other factors that have influenced the reduction in food waste. Therefore, to fully assign the reduction in food waste to the introduction of the interventions would be too limited. Despite that, do the results show that there is a weak and moderate correlation between the number of actions used to reduce serving- and plate waste and the amount of waste per portion. These results support the thought that the use of actions and interventions to address a specific food category help to reduce food waste in these categories.

The results also show that four of the twelve studied catering units still do not know were in their process they produce most of their food waste (kitchen-, serving-, or plate waste). Besides, ten of the twelve catering units studied overestimate the number of guests they have daily. These misconceptions may cause catering units to focus on the wrong problem and/or generate more food waste.

This study is a good basis for how the effect of introducing interventions for reducing food waste can be quantified and examined. With some improvements to the method, this may become a helpful tool for municipalities and catering units to examine which interventions are most viable for implementation.

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Appendix

Appendix A: Questionnaire (Translated to English)

1. Name kitchen
2. How many guests do you have daily?
3. Do you serve food to other kitchens?
    a. No
    b. Yes. how many portions per day? …
4. How big are the portions you serve (on average)?
    a. <100 g
    b. 100 – 200 g
    c. 201 – 300 g
    d. 301 – 400 g
    e. 401 – 500g
    f. > 500 g
5. Which waste category generates most of the food waste in your catering unit?
    a. Kitchen
    b. Serving
    c. Plate
    d. I do not know
    e. Other …
6. What are you currently doing to reduce food waste in your kitchen?
7. Are the following statements true about your kitchen?
    a. Yes
    b. No
        1. We have a specific goal set for how much and when to reduce food waste
        2. We have specific guidelines we follow for reducing food waste
8. Are the following statements true about your kitchen?
    a. Totally agree
    b. Agree on a high degree
    c. Agree on a low degree

d. Disagree

3. We measure the food waste we generate
4. We show the results of the food waste measurements to our kitchen staff
5. We show the results of the food waste measurements to the pupils and other people eating in the kitchens
6. We have proper funding to reduce food waste
7. We do point measurements if food waste is high in particular areas
8. Before purchasing new stock we check and use our current stock
9. We base our stock purchases on previous consumption
10. We order fresh products close to the date of use
11. We buy products in packages of different sizes
12. We try to buy food that has a long shelf life
13. In our storage, we place our stock according to the principle first in -first out
14. We have a good overview of our stock
15. We freeze fresh products that are not consumed immediately
16. We label opened packages with dates and contents
17. We know the difference between the best before and used by labels on our products
18. We keep our fridge at 4 ° C
19. We have a routine to save food if the freezer breaks
20. We store our stock properly
21. We cook just enough
22. We put our cooked food in containers of different sizes
23. We use a thermometer when cooking
24. We cook the food in batches
25. We evaluate recipes and leave comments to the recipe manager
26. We let frozen food thaw (defrost) slowly in the fridge
27. We do not peel and groom fruit and vegetables more than necessary
28. We have a flexible menu with room for change
29. We plan the menu with versatile and varied food that is appreciated
30. We involve the pupils in the menu planning
31. We visit other kitchens to exchange ideas
32. We plan recurring dishes and ingredients in the menu

33. We give our served dishes appropriate names that describe what they contain
34. We plan the menu according to the delivery days
35. We know how much one pupil eats
36. We give feedback to the recipe manager if we think that the portions are too big or too small for the pupils
37. We have a routine for reporting attendance and absence
38. We base the amount we cook on daily attendance and absence
39. When serving the food we only add as much food as is expected to be consumed
40. When serving the food we bring out one tray at the time
41. During serving time staff behind the serving, bars give feedback to the cooks in the kitchen
42. We use smaller trays at the end of the serving time
43. We count the number of plates used to keep track of how many people have eaten
44. We reuse leftovers
45. We collect and create recipes for how to use leftovers in new dishes
46. Staff or pupils are allowed to take (or buy) leftovers
47. We create conditions for a pleasant meal environment
48. We give the pupils enough time to eat their lunch
49. We educate our pupils about what the benefits are of not throwing away food
50. We give the pupils the opportunity to taste the food before taking a whole plate

Appendix B – Questionnaires statements divided per category

	Livsmedelverket, 2020
	Raider, 2019

Quantification and follow up

1	We have a specific goal set for how much and when to reduce food waste
2	We have specific guidelines we follow for reducing food waste
3	We measure the food waste we generate
4	We show the results of the food waste measurements to our kitchen staff
5	We show the results of the food waste measurements to the pupils and other people eating in the kitchens
6	We have proper funding to reduce food waste
7	We do point measurements if food waste is high in particular areas

Kitchen waste

8	Before purchasing new stock we check and use our current stock
9	We base our stock purchases on previous consumption
10	We order fresh products close to the date of use
11	We buy products in packages of different sizes
12	We try to buy food that has a long shelf life
13	In our storage we place our stock according to the principle first in -first out
14	We have a good overview of our stock
15	We freeze fresh products that are not consumed immediately
16	We label opened packages with dates and contents
17	We know the difference between the best before and used by labels on our products
18	We keep our fridge at 4 ° C
19	We have a routine to save food if the freezer breaks
20	We store our stock properly
21	We cook just enough
22	We put our cooked food in containers of different sizes
23	We use a thermometer when cooking
24	We cook the food in batches
25	We evaluate recipes and leave comments to the recipe manager
26	We let frozen food thaw (defrost) slowly in the fridge
27	We do not peel and groom fruit and vegetables more than necessary

Serving waste

28	We have a flexible menu with room for change
29	We plan the menu with versatile and varied food that is appreciated
30	We involve the pupils in the menu planning
31	We visit other kitchens to exchange ideas
32	We plan recurring dishes and ingredients in the menu
33	We give our served dishes appropriate names that describe what they contain
34	We plan the menu according to the delivery days
35	We know how much one pupil eats
36	We give feedback to the recipe manager if we think that the portions are too big or too small for the pupils
37	We have a routine for reporting attendance and absence
38	We base the amount we cook on daily attendance and absence
39	When serving the food we only add as much food as is expected to be consumed
40	When serving the food we bring out one tray at the time
41	During serving time staff behind the serving bars give feedback to the cooks in the kitchen
42	We use smaller trays at the end of the serving time
43	We count the number of plates used to keep track of how many people have eaten
44	We reuse leftovers
45	We collect and create recipes for how to use leftovers in new dishes
46	Staff or pupils are allowed to take (or buy) leftovers

Plate waste

47	We create conditions for a pleasant meal environment
48	We give the pupils enough time to eat their lunch
49	We educate our pupils about what the benefits are of not throwing away food
50	We give the pupils the opportunity to taste the food before taking a whole plate

Appendix C – Answers on questionnaire statements per school

Legend:

3	Totally agree
2	Somewhat agree
1	Somewhat disagree
0	Disagree

		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
Quantification and follow up	1	0	0	0	0	0	0	3	2	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	3	2	2	3	3	3	3	3	3	2	3	3
	4	3	0	2	3	3	3	3	3	3	2	3	3
	5	2	1	3	2	2	1	3	3	3	2	1	2
	6	1	1	1	0	1	0	0	1	1	1	1	1
	7	0	2	0	2	0	0	2	0	3	0	2	1
Kitchen waste	8	3	2	3	3	3	3	3	3	3	2	2	3
	9	2	2	3	2	2	0	3	3	3	3	3	3
	10	1	1	0	3	1	2	3	3	3	3	3	3
	11	2	2	0	3	2	3	2	3	3	2	3	3
	12	2	0	0	2	2	0	2	3	2	1	2	2
	13	3	3	3	3	3	3	2	3	3	3	3	3
	14	2	2	3	3	2	3	3	3	3	3	2	3
	15	2	2	3	2	2	3	3	3	3	2	1	2
	16	2	3	2	3	2	3	3	3	3	2	2	3
	17	2	3	3	3	2	3	3	3	3	3	3	3
	18	2	2	2	3	2	2	3	3	3	2	2	3
	19	1	2	0	3	1	2	3	3	3	1	1	3
	20	2	3	3	3	2	3	3	2	3	3	2	3
	21	3	2	2	2	3	3	3	2	3	2	2	2
	22	3	0	3	2	3	2	3	3	3	2	2	3
	23	3	3	1	3	3	3	3	3	3	2	3	3
	24	2	3	0	1	2	3	3	3	2	2	2	1
	25	1	2	1	2	1	3	3	0	3	1	1	2
	26	3	2	2	3	3	2	3	3	3	2	2	3
	27	2	2	3	3	2	3	3	3	3	2	2	3

Serving waste	28	2	2	2	2	2	2	3	2		3	2	2	2
	29	2	2	2	2	2	2	2	2		3	2	3	3
	30	2	1	1	0	2	1	0	1		2	0	1	1
	31	1	1	1	1	1	1	1	1		3	1	1	1
	32	2	2	2	2	2	0	3	2		3	2	2	3
	33	2	2	1	3	2	2	2	2		3	1	2	2
	34	1	1	0	1	1	1	2	2		1	1	2	1
	35	1	2	2	2	1	0	2	2		3	1	2	2
	36	1	0	0	1	1	2	2	2		3	1	1	1
	37	1	3	3	3	1	2	0	3		3	3	3	3
	38	1	2	2	3	1	2	0	3		2	2	2	3
	39	2	2	3	3	2	3	3	2		3	2	2	2
	40	2	2	3	2	2	3	3	2		3	2	2	3
	41	3	2	3	2	3	3	2	2		3	1	2	3
	42	2	2	0	2	2	3	2	2		3	0	1	3
	43	1	2	0	0	1	2	0	0		0	0	0	0
	44	3	3	2	2	3	3	3	2		3	2	1	2
	45	1	3	0	1	1	2	3	1		2	1	1	1
	46	0	0	0	0	0	0	0	0		0	0	0	0
Plate waste	47	2	3	2	2	2	2	3	2		1	2	2	1
	48	1	2	2	0	1	0	0	3		3	1	1	2
	49	2	1	1	3	2	1	1	2		3	2	1	3
	50	3	3	1	2	3	3	0	3		3	1	2	3

Sveriges Lantbruksuniversitet
Institutionen för energi och teknik
Box 7032
750 07 UPPSALA
http://www.slu.se/institutioner/energi-teknik/

Swedish University of Agricultural Sciences
Department of Energy and Technology
P. O. Box 7032
SE-750 07 UPPSALA
SWEDEN
www.slu.se/en/departments/energy-technology/