

# Food Supply Chain Actors' View on Food Waste and Packaging: A Case Study on Iceberg Lettuce

Alexandra Mansner and Jiyao Wang

DIVISION OF PACKAGING LOGISTICS | DEPARTMENT OF DESIGN SCIENCES  
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MASTER THESIS



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Alexandra Mansner and Jiyao Wang



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Department of Design Sciences  
Faculty of Engineering LTH, Lund University  
P.O. Box 118, SE-221 00 Lund, Sweden

Subject: Packaging Logistics (MTT920),  
Division: Packaging Logistics  
Supervisor: Christina Skjöldebrand  
Examiner: Annika Olsson

# Abstract

Food waste is currently a significant problem in today's society where up to one third of all produced food is wasted before being consumed. The wastage occurs throughout the whole food supply chain but the largest contribution is generated in the households. Food waste is a problem which results in negative effects on the economy, the society as well as the environment. There are a myriad of factors affecting the wastage, one of which being packaging. Reduced waste can be achieved by 13 of packaging's 19 different features.

The purpose of this study is to investigate the reasons for food waste in the different stages of the food supply chain, how the supply chain actors view food waste and packaging as well as how packaging can potentially reduce food waste. Furthermore, iceberg lettuce is used as a case study to provide a deeper understanding of food waste and packaging related to a specific product. The results of this study involve both food waste in general as well as iceberg lettuce waste.

Based on 28 interviews with consumers, retailers, distributors and producers, the results show that all supply chain actors are aware of waste being a problem in the food industry. However, there are a number of obstacles and challenges that need to be overcome in order to reduce the wastage, such as lacking motivation, knowledge and awareness among consumers. Furthermore, actors' failure in realizing packaging's potential in reducing food waste, contradicting financial incentives as well as the challenge of maintaining a cold chain are also shown to be factors affecting food wastage in the supply chain. Moreover, five packaging features with the potential to reduce iceberg lettuce waste are identified.

**Keywords:** food waste, supply chain, packaging, iceberg lettuce, food waste reasons

# Acknowledgments

Working on this master thesis has been inspiring as well as challenging and it has opened our eyes to the food waste problem and packaging's role in reducing the wastage. This thesis would not have been possible to accomplish without the support from a number of helpful people.

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Lund, May2017

Alexandra Mansner and Jiyao Wang

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# Introduction

*This thesis work aims to give a better understanding of the different supply chain actors' views and behaviors regarding food waste and its connection to packaging. This chapter presents the background, purpose and research basis, focus and limitations, target group and report structure of this thesis.*

## 1.1 Background

Today, close to a billion people are starving in the world (FAO, 2017) and yet, according to the European Commission, 88 million tons of food are wasted every year in the EU (European Commission, 2017). Up to one third of all produced food is wasted before being consumed and the majority of the food wastage comes from the consumers (FAO, 2017). Food waste is generated at all supply chain stages from production to consumption (FAO, 2011). Therefore, food wastage is clearly a problem that needs to be addressed in the whole food supply chain. The consequences of food waste are many and involve economic (e.g. increasing costs), social problems (e.g. health impacts) as well as environmental (e.g. unnecessary energy and water usage) (Fusions, 2016). According to the Swedish Environmental Protection Agency (EPA), the food production in Sweden answers for 20-25 percent of the country's total environmental impact (Swedish EPA, 2016).

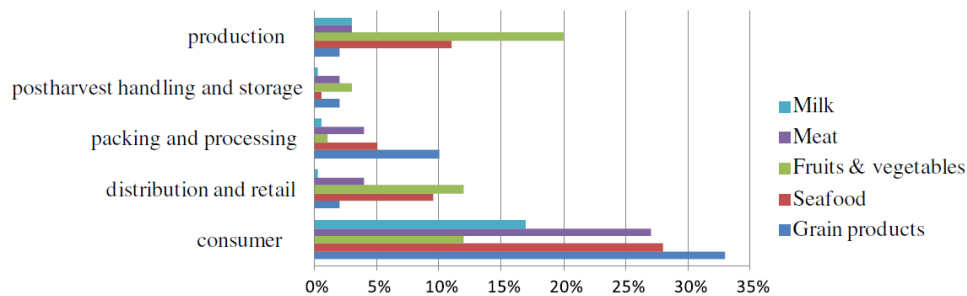
### 1.1.1 Definition of food waste

The definition of food waste used in this thesis is the following:

*“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)*

### 1.1.2 Waste in the food supply chain

In the academic world, there are more and more research talking about food waste from a supply chain perspective. For instance, Parfitt, Barthel, and Macnaughton(2010) provide examples of how food waste may arise in each stage of the food supply chain, from harvesting to the disposal of food waste. The examples include edible crops being left on the fields, contamination or process losses in the production stage, damage during transportation, pasted “best-before-date”, et cetera. Gunders (2012) estimates how much food is wasted at each stage of the supply chain from field to fork for the USA, Canada, Australia, and New Zealand. The results from this research are summarized by Wikström, Williams, Vergheze, and Clune (2014) in Figure 1. It illustrates that food waste is generated throughout the whole supply chain but that consumers contribute the most to the total amount of food waste. However, the production stage also contributes to a large part of the wastage related to fruits and vegetables.



**Figure 1** The percentage of food waste from each phase (Wikström et al., 2014).

Certainly, numbers on food waste can alert people of how large the amounts of food waste actually are but it is still difficult to obtain exact food waste amounts in reality because of the poor data resolution. Therefore, the main focus of this thesis is to understand why the food waste occurs in the supply chain rather than quantifying the waste.

### 1.1.3 Packaging related to food waste

Packaging has an important role in, among others, identifying, containing and protecting the product throughout the supply chain from the product production to its consumption (Paine, 1991). Without packaging the product would be hard to handle in the different supply chain operations and it would be exposed to a great risk of damage and contamination. According to Robertson (2012), the packaging community accounts for two percent of the gross national product (GNP) in developed countries and around half of this is related to food packaging. Throughout its life cycle, the packaging material impacts the environment in many ways, for example, energy and natural resources are needed to produce the

packaging which leads to emissions and at the end of its life cycle the packaging will become waste that needs to be disposed of (Robertson, 2012).

According to Molina-Besch and Pålsson (2016), better packaging designs can reduce the impact a supply chain has on the environment by minimizing product waste as well as energy needed in logistics and amount of packaging material. Additionally, Verghese, Lewis, Lockrey, and Williams (2013) also acknowledge the potential packaging has on reducing waste, in this case food waste, throughout the supply chain.

## 1.2 Purpose and research questions

In this chapter, the main purpose and the research questions of the study will be presented and in the concluding part of the thesis, the research questions will be answered based on an analysis of both theoretical and empirical data.

Verghese et al. (2015) show that packaging can reduce food waste in general throughout the whole supply chain and this thesis will use one food item as a case study to see how packaging could potentially affect its wastage specifically. Eriksson et al. (2012) show that fruits and vegetables is the most wasted food category in retail stores and lettuce is the third most wasted item in this category. Because there has been some previous research done on iceberg lettuce in Sweden, for instance Strid et al. (2014), and it is one of the most common lettuce types in Sweden, this thesis will use iceberg lettuce as a case study. The results from this study can be relevant to similar products to iceberg lettuce as well as provide inspiration for how to evaluate the potential of other products' packaging to reduce food waste.

The purpose of this master thesis is consequently to study the reasons for food waste in the different stages of the food supply chain, how different actors in the supply chain view food waste and packaging as well as how packaging can potentially reduce food waste. Iceberg lettuce is used as a case study in this thesis and therefore the results will involve both foodwaste in general as well as iceberg lettuce waste.

In order to achieve the purpose mentioned above, this master thesis will answer the following questions:

- What challenges and opportunities are there for the actors in the supply chain, i.e. from farm to household, concerning food waste, especially iceberg lettuce waste?
- What challenges does the packaging system have related to food waste, especially iceberg lettuce waste, in the supply chain?

- How can packaging designs potentially reduce iceberg lettuce waste in the supply chain?

## 1.3 Focus and delimitations

This study is aiming to gain a better understanding of the reasons for the occurrence of food waste in the supply chain and how packaging is related to the wastage. Since the thesis involves a case study, the main focus will be on the study object, namely iceberg lettuce. This study will focus on one of the possible supply chain paths for iceberg lettuce presented by Strid et al. (2014), see Appendix A, in this case the one including a producer, distributor, retailer and consumer. Other branches of the supply chain will not be considered in this study.

In this thesis, extra focus will be concentrated on collecting data about consumers' behaviors and opinions regarding food waste and packaging, in particular with regards to iceberg lettuce. This is due to the fact that research has previously been done regarding iceberg lettuce waste in production and distribution (Strid et al., 2014) as well as in retail stores (Eriksson et al., 2012) but hitherto no research has been done about iceberg lettuce waste in households.

## 1.4 Report structure

### **1. Introduction**

In this chapter, background about the definition of food waste, food waste in the supply chain and packaging related to food waste is firstly introduced. After that, the main purpose and research questions of this thesis are presented as well as the focus and delimitation, target group and report structure.

### **2. Methodology**

In the second chapter, different research approaches and concepts are introduced and then the appropriate methodological decisions are chosen and motivated. The chosen data collection methods, that are literature studies, interviews and observations, are explained and motivated. Finally, an introduction of the interviewees is made in the end of the chapter.

### **3. Theory**

Based on literature studies, the various reasons for food waste as well as the opportunities to reduce food waste in the supply chain, are listed actor by actor. Furthermore, different packaging opportunities related to reducing food waste are

highlighted. In addition, the characteristics of iceberg lettuce are also included in this chapter.

#### **4. Results**

In this chapter, the supply chain and the packaging system of iceberg lettuce are firstly described. Then the detailed results of the conducted interviews with each actor in the supply chain will be presented.

#### **5. Discussion**

In the discussion, the empirical data will be analyzed and its connection to the theory will be explored

#### **6. Conclusions**

In this chapter, the answers to the three research questions and the main conclusions are presented.

#### **7. Future research**

In the final chapter, the future research is discussed.

## 2 Methodology

*In this chapter, different research approaches and concepts will be explained firstly and the related choices made in this study will be presented and motivated. Then the data collection methods used in this study will be discussed.*

### 2.1 Research approach and concept

#### 2.1.1 Research approach

There are three different research approaches; abductive, inductive and deductive. The abductive approach is a study process of the systemic circulation between theory and practice with the goal of finding the appropriate theory for empirical observations. For the deductive approach, the researcher starts with the theory, tests the theory to the empirical settings and gets general conclusions, while for the inductive approach, the researcher starts with collecting data and tries to find the general laws or theoretical conclusions in the end. (Kovács&Spens, 2004)

In this master thesis the abductive approach is used. The theoretical knowledge of food waste in the supply chain and packaging's effect on food waste will be combined with the empirical data of how each actor wastes food and why, then the suggestions of improvements will be presented in the end.

#### 2.1.2 Quantitative and qualitative studies

A study can be quantitative, qualitative or a combination of the two. A study that is quantitative consists of results that can be measured and quantified. However, not all results can be quantified which is a limitation for this method. A qualitative study is used when the aim is to get a deeper understanding of underlying reasons, motivations and opinions (Björklund&Paulsson, 2014).

The main objectives of this thesis include getting an understanding of what affects food waste, especially iceberg lettuce waste, in the supply chain and the potential impacts packaging can have on the wastage. This study will therefore involve mostly non-quantifiable results, thus the research will be mostly qualitative. The

type of study is important when choosing the appropriate data collection methods. Interviews and observations are well suited for qualitative studies and will hence be used in this master thesis (Björklund&Paulsson, 2014). Furthermore, the purpose of this thesis is to gain a deeper understanding regarding opinions and behaviors related to food waste and packaging and interviews is an advantageous data collection method in this case.

### **2.1.3 Form of study**

There are four different forms of studies, namely exploratory, descriptive, explanatory and normative studies. The exploratory studies are used for getting a deeper understanding of something and they are often used when there is little previously known about the topic. Descriptive studies are used when the aim is to describe, rather than explain, how something works and when there is already a lot of knowledge about the topic. Explanatory studies are useful when the aim is to understand on a deeper level what causes a phenomena and what affects it has by both describing and explaining. The normative studies are used when there already exists some knowledge about the topic and when the aim is to find a solution to a certain problem (Björklund&Paulsson, 2014).

The main part of this study is explanatory in the sense that the objective is to understand the food waste phenomena at each supply chain actor and what impact packaging has on it. However, in the final part of the thesis, the theory and the empirical data will be combined to suggest how packaging design can reduce the iceberg lettuce waste, which is a normative form of study.

### **2.1.4 Approach to knowledge**

The aim of a study can be affected by a person's view of knowledge (Björklund&Paulsson, 2014) and it is therefore important to define which one is used in a specific study.

According to Björklund and Paulsson (2014), a person can either have an analytical, a systems or an actor approach to knowledge. The analytical approach means that the knowledge does not depend on the observer. A problem can be divided into independent parts that can be solved independently and when put back together, will give the solution to the whole problem. A systems approach means that the original problem cannot be solved without considering the connections and relations between the different parts of the whole problem. The actor approach means that the knowledge is dependent on the observer and its experience and actions.

In this master thesis, a system approach has been used because it is important to understand the whole supply chain and how different parts affect each other since

the root cause and the effects of food waste do not always occur at the same actor (Lindbom, Forsman, Gustavsson&Sundström, 2014).

### **2.1.5 Measures of credibility**

For the results of a research to be believable it is important that the credibility of the study is high. There are three aspects that affect the credibility, namely the validity, the reliability and the objectivity. Validity refers to how well the results correspond to the intended aim of the study while reliability is related to how reliable the results are, that is whether or not the results change if the study is repeated. Lastly, objectivity refers to how different values affect a study (Björklund&Paulsson, 2014).

The higher these three aspects are, the more credible the study is. However, there is a tradeoff here because in order to ensure a high credibility, resources are needed (Björklund&Paulsson, 2014). This thesis consists mostly of qualitative research and to improve the validity of the study, three data collection methods will be used. This approach is called triangulation. The degree of triangulation that will be present in this study is limited by lack of time and resources. In order to increase the objectivity of the study, the different choices made in this thesis will be clearly stated and motivated.

## **2.2 Data collection methods**

Data collection is one of the most important steps in the research process. It is worthy to take time to consider the available methods of data collection, the advantages and disadvantages of using them and whether they are suitable to the established research focus. Furthermore, it is important to ensure that they can be implemented with regards to time, resources and constraints related to the study (Brewerton &Millward, 2001).

The three data collection methods used in this study are explained and motivated below in the final sections of this chapter.

### **2.2.1 Literature studies**

A literature study means collecting information from all types of written and reproduced material, such as books and reports. This method generates secondary data and it is necessary to be aware of the fact that the data might be partial or incomplete. Literature studies are used in this thesis because it is an economically cheap method that can generate large volumes of information. It is also helpful in



getting a good understanding of what is currently known about a topic. However, because it is secondary data, it is important to always be critical of the generated information and to ensure it is used in an appropriate way (Björklund&Paulsson, 2014).

Relevant literature has mainly been gathered through databases such as LUB Search and Lovisa as well as via search engines such as Google and Google Scholar. The keywords mostly used are food waste, iceberg lettuce, supply chain, packaging and food waste reasons.

### 2.2.2 Interviews

Interviews can generate knowledge of human situations, to show how the subjects describe their activities, experiences and understanding of the world (Kvale, 2008). There are four types of interviews: structured, unstructured, semi-structured and ethnographic. For structured interviews, the interviewer prepares before the interview a set of questions with one or more fixed options for the interviewee to choose from. The data given by this method can be easy to collect and quantify but it does not allow the interviewee to further explore areas of interest. On the contrary, in unstructured interviews, the interviewee is given a number of topics but the questions and order of the topics are not fixed. This method can generate data with a great richness. Semi-structured interviews combine the first two methods. They have the advantage of having both quantitative and qualitative analysis but they also require the interviewer to be skilled in order to lead and control the conversation. Ethnographic interviews are similar to unstructured interviews but the interviewer suggests directions for the discussion rather than controls the interviewee. They provide more freedom and informality for the informant which can result in the data not necessarily being true or reliable (Brewerton&Millward, 2001).

In this thesis, semi-structured interviews are used because the aim is to understand people's opinions and behaviors related to specific topics regarding food waste and packaging. A set of interview questions are prepared (see Appendix B) before the interview, to give the interviewer a structure to follow and to ensure all topics of interest are covered during the interview. However, most of the questions are open which allows the interviewee to answer them with more freedom and room for deeper opinions. The interview structure is flexible which means the structure can be changed during the interview in order to be able to cover unforeseen topics of interest that might appear. The data collected through the interviews is analyzed by identifying underlying general patterns as well as detecting specific behaviors and opinions related to food waste and packaging. The interview results are discussed in chapter 5.

### 2.2.2.1 Introduction of the interviewees

In this section, a general introduction of the interviewees will be given.

#### 2.2.2.1.1 Consumers

Different countries have different cultures and ways of working which is likely to affect people’s opinions and behaviors related to food waste, iceberg lettuce waste and packaging. In order to be able to compare and analyze the reasons for food waste in Sweden and its potential prevention methods, it is important that the interviewees are familiar with the Swedish food and waste culture. Therefore, the consumers interviewed in this study are people who have lived in Sweden for at least five years.

There are 17 consumer interviewees included in this research: 5 males and 12 females. The age distribution of the interviewees is shown below in Figure 2 and the ages range from 26 to 86 years. The main reason for selecting these interviewees is to cover both genders and different ages, so that the data collection will be as representative of the total Swedish population as possible. However, how well the interviewees represent the Swedish population is limited by the time and resource constraints of this study. For instance, the majority of the interviewees are females and living in the south of Sweden. This is an error source that needs to be taken into consideration when viewing the results of this study.

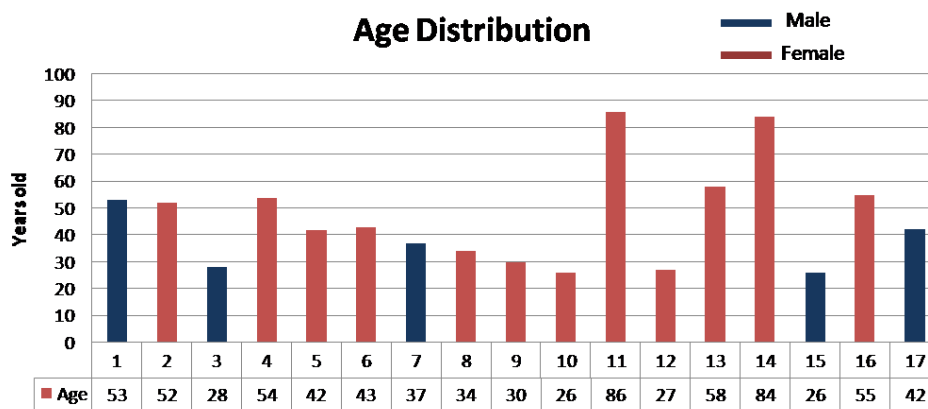


Figure 2 Age distribution of interviewed consumers (Mansner & Wang, Personal figure, 2017).

#### 2.2.2.1.2 Retailers

Four store managers from retail stores in Lund are interviewed in this study. They all belong to large retail food chains and they come from three different companies. Also, one founder and one employee from two shops with a package-free concept are interviewed as well. These two retailers do currently not sell iceberg lettuce but they represent a new form of retailer and they could potentially be part of the

iceberg lettuce supply chain in the future. They are included in this study because they provide a different perspective of viewing food waste and packaging.

#### 2.2.2.1.3 Distributors

Two distributors are interviewed in this study. Both of them are international transport companies. However, one is mainly providing fresh fruits and vegetables to wholesalers and retailers while the other offers a range of different logistic services but the focus in this thesis will be on the transport of temperate goods. The fact that the two distributors have different focus allows for richer and more representative data.

#### 2.2.2.1.4 Producers

In this study, three iceberg lettuce producers from the south of Sweden are interviewed. One of the producers is rather large with 700 hectare of land while the other two are smaller producers. They might have different opinions and experiences regarding food waste and packaging depending on the size of their business which adds richness to the collected data. However, because the size difference might affect the data collected from each producer, it is important to recognize this size difference when analyzing the results.

### 2.2.3 Observations

There are two types of observations: participant observation and non-participant observation. The participant observation is used when the researcher interacts with the observed people so that the researcher can, through an insider's viewpoint, observe what, where and how things happens (Schwartzman, 1993). The participant observation is an in-depth, qualitative, case study approach and design method (Jorgensen, 1989). In the non-participant observation, the researcher does not interact with the observed people (Gold, 1958). As a result, the researcher can receive the most natural behavior from the observed people and even the groups that are hard to reach and observe. However, it is difficult to observe tight groups and it can be unethical in some cases.

In this research, observations are used for collecting information about iceberg lettuce from the retail stores. Different packages of iceberg lettuce are observed and various methods of storing iceberg lettuce on the shelves are studied. Since the researchers do not participate in the process, non-participant observations are used in this study.

## 3 Theory

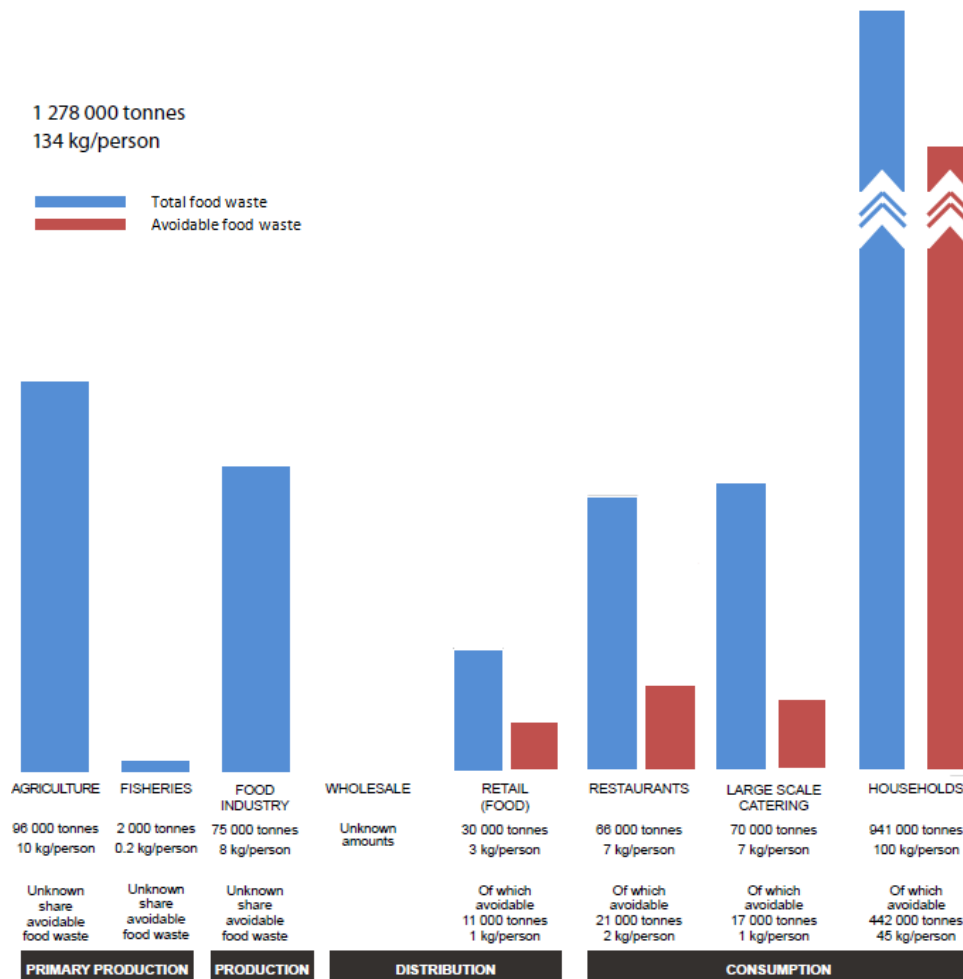
*In this chapter, the reasons for food waste in the supply chain and how packaging design reduce food waste are introduced based on literature studies.*

### 3.1 Food waste in the supply chain

Today, close to a billion people are starving in the world (FAO, 2017) and yet, according to the European Commission, 88 million tons of food are wasted every year in the EU (European Commission, 2017). Up to one third of all produced food is wasted before being consumed and the majority of the food wastage comes from the consumers (FAO, 2017). Food waste is generated at all supply chain stages from production to consumption (FAO, 2011). Therefore, food wastage is clearly a problem that needs to be addressed in the whole food supply chain. The consequences of food waste are many and involve economic (e.g. increasing costs), social problems (e.g. health impacts) as well as environmental (e.g. unnecessary energy and water usage) (Fusions, 2016). According to the Swedish Environmental Protection Agency (EPA), the food production in Sweden answers for 20-25 percent of the country's total environmental impact (Swedish EPA, 2016).

According to a report published by the Swedish EPA (2016), almost 1.3 million tons of food were wasted in Sweden during 2014, see Figure 3. The figure shows the amount of food waste in each stage of the supply chain, including primary production, production, distribution and consumption. The households, which are part of the consumption stage, are the largest contributors to the total volume followed by the agriculture in primary production. However, waste is generated throughout the whole food supply chain. The fact that consumers waste the largest amounts of food has been seen in other countries as well (Lee, Willis & Hollins, 2010; Gunders, 2012). In the waste calculations presented in the Swedish EPA (2016), food from the food industry that becomes animal feed is not considered

food waste. Furthermore, the waste volume for the wholesaler stage is not included due to incomplete data. In the report, avoidable food waste is food that could have been eaten had it been handled correctly and eaten before its best-before-date. The avoidable food waste is represented in Figure 3 by the second column in red. Unavoidable food waste is waste that is generated during food preparation or production and difficult to reduce, such as peels and coffee grounds. The unavoidable wastage is represented in Figure 3 by the difference between the red and the blue columns for each actor. The allocation of avoidable and unavoidable waste in primary production and production is unknown and therefore only the total amount of waste is presented in Figure 3. In order to reduce the food wastage, the Swedish EPA (2016) claims it is important to know where the wastage occurs and how large the amounts are. By reducing the food wastage, the financial and environmental impacts caused by the food supply chain would decrease (Swedish EPA, 2016).



**Figure 3**The volumes of food waste generated in Sweden 2014 (Swedish EPA, 2016).

In the following sections, the current knowledge about what causes food waste at different stages in the food supply chain will be presented. Because of the limitations of this master thesis, see section 1.3, only the reasons for agricultural producer, distributor, retailer as well as consumer food waste will be touched.

### **3.1.1 Agricultural producers**

According to the Swedish EPA (2012), the unpredictable weather and uncertainty related to consumer demand are two of the main reasons for food waste in the primary production. The producers need to hedge against the uncertainty by planting more than they plan to sell (Gunders, 2012). Another factor that has a large impact on the production uncertainty is the risk of crops developing diseases which can lead to them being unsellable (Gunders, 2012). Additionally, the producers' food wastage could increase if they are not able to fulfil the retailers' quality requirements (Verghese et al., 2015).

If the market price of the crops is lower than the cost of harvesting and delivering them to the market, then it is more profitable for producers to leave the crops unharvested. Other factors affecting the food wastage are the access to workers that can harvest the crops as well as if there has been any food safety scares related to the crops. (Gunders, 2012)

Gunders (2012) suggests in his report a collection of methods that could potentially reduce the food wastage at the production stage of the food supply chain. The methods include, among others, revising the quality requirements to include a larger amount of products, introducing legal incentives to harvest all fields and selling imperfect products on another market.

### **3.1.2 Distributors**

Damages to the packaging can cause food waste in the distribution stage as well as confusions about a product's quality and safety (Verghese et al, 2015). Other factors contributing to the food wastage are product mishandling, temperature fluctuations as well as cancelled shipments. It is important that the products, especially the perishable ones, are handled with care during the operations carried out during distribution as well as during transport. For certain products the temperature that they are kept in is crucial for their quality and failing to meet these temperature requirements can lead to food waste. If a buyer cancels a shipment then the distributor will be left with the products and if the products are perishable then it is important that the distributor finds another buyer before the products expire. (Gunders, 2012)

To prevent food waste at the distribution stage from occurring, the workers should be trained in correctly handling the products and the equipment used in the distribution should be properly maintained. (Gunders, 2012)

### **3.1.3 Retailers**

The largest wastage at the retailer stage is generated by perishable products, such as vegetables and meat, and the fact that retailers are not striving to reduce this waste as much as possible. If the wastage of perishable products is small-scaled, then the retailers can view it as a cue that they are understocked and the customer experience is therefore affected negatively. (Gunders, 2012)

According to Verghese et al. (2015), food waste can be generated at the retail stage due to excess stock, poor stock rotation or multiple handling of fresh products. Other potential reasons for food waste are consumers' quality requirements, expired best-before-dates and leftover promotional products (Gunders, 2012). Additionally, too large order quantities, non-optimal storage and handling are reasons for wastage of fruit and vegetables (Mattsson, 2014).

Gunders (2012) presents a few methods of reducing the retail food waste. Products that are on the verge of becoming waste can be sold to a reduced price, the shelf life of the products can be extended or the forecasting related to product promotions can be improved. Regarding fruit and vegetables, correct cooling and handling as well as avoiding stacking products on top of each other on the store shelves, can reduce the wastage (Mattsson, 2014).

### **3.1.4 Consumers**

In 2014, Swedish households wasted 941 000 tons of food and is therefore the largest contributor to the total amount of food waste generated in Sweden (Swedish EPA, 2016). Fruit and vegetables is the most wasted food category. Food wasted in the end of the supply chain rather than in the beginning, contribute more to the energy wastage because energy has been used throughout the supply chain to prepare and deliver the product to the end-consumer (Dobbs, Oppenheim, Thompson, Brinkman&Zornes, 2011).

In the United Kingdom, research has been done on consumers' perceptions and behaviors related to food waste. The results show that in general consumers are of the opinion that they do not waste much food and when they do waste they view it as disposing food that is inedible due to unexpected events. According to the report, important reasons for food waste in households are not being able to finish the food before it perishes, forgetting the food is in the household, not eating the food that is cooked and cooking too large amounts of food (WRAP, 2007). Other

reasons are lack of planning when buying food, inadequate knowledge in how to store the food and confusion related to date labels (Lee et al., 2010).

According to Plumb, Downing and Parry (2013), consumers' perception of food packaging can also be a reason for food waste. Consumers are usually aware of the fact that packaging protects food in the earlier stages of the supply chain but they tend to think that packaging actually makes the food spoil faster in the households. This makes consumers remove food items from their original packages which could make the food spoil quicker than necessary. Nearly two out of three consumers believe that fruit and vegetables will go bad faster if kept in their original packaging. Additionally, the majority of consumers feel confident that they know how to store food at home. A study conducted by Williams et al. (2011) suggests that 20-25 percent of household food waste is associated with packaging features, such as the size of the food package and how easy it is to empty.

Aschemann-Witzel, de Hooge, Amani, Bech-Larsen and Oostindjer (2015) conclude in their report that sociodemographic factors such as the number of household members and their age affect the amount of food a household wastes. To illustrate, the report mentions that people who have grown up during war times tend to waste less. Consumers' concerns, awareness and behaviors, i.e. psychographic factors, also affect how much food consumers waste. For instance, if people are motivated to avoid food waste then they are more likely to generate less waste than unmotivated consumers. (Aschemann-Witzel et al., 2015)

Gunders (2012) claims that the food waste caused by households could be reduced by educating consumers about food quality and expiration, e.g. that food is not necessarily inedible just because its best-before-date has passed. Additionally, Gunders (2012) states that planned food shopping and preservation of food by freezing it, are other factors that have the potential to reduce the food wastage. Nevertheless, WRAP (2017) indicates in their report that the reduction of household food waste has stalled in the UK despite extensive reduction efforts. The lack of results is believed to be due to an increasing population, decreasing food prices and increasing personal incomes.

### 3.2 Reducing food waste through packaging design

Previous research has shown that packaging has the potential to reduce food waste. Out of packaging's 19 different features, 13 of them can contribute to less product waste (Lindh, Williams, Olsson & Wikström 2016). In this section of the thesis, different ways of designing packaging to reduce product waste that have been identified in the literature, will be presented.

**Protective packaging.** By protecting the product from the external environment and from physical damage, the amount of product waste can be reduced (Molina-



Besch&Pålsson, 2016). To do this, it is important to have a good understanding of the product and its supply chain. However, it is not sustainable to use too much packaging material, i.e. over-packing, either because it leads to higher packaging costs and an increased impact on the environment. Therefore, it is important to find the optimal amount of packaging that gives sufficient product protection without over-packing, see Figure 4.

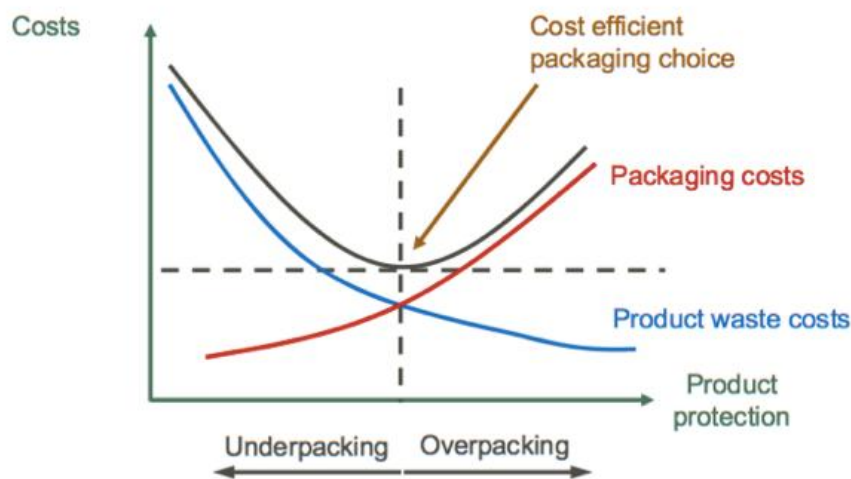


Figure 4 Graph showing the most cost efficient packaging choice (Pålsson, 2016).

**Controlling temperature and ventilation.** The quality of food is affected by how it is stored, especially in what temperature and humidity (McCurdy, Peutz& Wittman, 2009). Some food products, such as fruits and vegetables, can be extra perishable. The preferable temperature differs from product to product but it is important that the temperature is stable to prevent damaging effects on the respiration and quality of the product (Department of Agriculture and Food, 2016). Packaging can, for instance through different packaging materials, contribute to a more efficient temperature and ventilation control throughout the supply chain (Verghese et al. 2015).

**Extending shelf life.** Packaging that increases the product's shelf life can reduce the product waste and perishable products with shorter shelf life are wasted more often than products with longer shelf life (Mena, 2011). Primary packaging is the most important packaging level regarding extending a product's shelf life (Verghese et al., 2015). One way of increasing the shelf life of food, according to Verghese et al. (2013), is to pre-pack and process food which would lead to a reduction of waste in the distribution as well as at the consumer stage of the supply chain. Furthermore, new packaging materials (Carrizo,Taborda, Nerin&Bosetti, 2015; Rahman, Mujeeb&Muraleedharan, 2016) and technologies (Lerasle et al., 2014; Janjarasskul, Tananuwong, Kongpensook, Tantratian&Kokpol, 2015) can also contribute to a longer shelf life.

**Right apportionment.** When deciding the size of primary packaging, the end-user's consumption should be taken into consideration to prevent leftovers that will become unnecessary waste (Molina-Besch&Pålsson 2016). Household sizes are decreasing in today's society (Liu, Daily, Ehrlich& Luck, 2003) and there is therefore currently a need for packages of sizes that are better adapted to these modern day households (WRAP, 2013). However, for consumers to purchase smaller-sized packages, the packages must become more financially appealing. Joutsela and Korhonen (2015) indicate that, today consumers tend to choose food packages of a larger size than they need because the price per weight unit is lower.

**Education about dates.** All supply chain actors, from manufacturer to consumer, should be educated about the use-by and best-before date marks on primary packaging to make sure they are used accurately. Lack of knowledge leads to good and edible food being thrown away (Verghese et al., 2013). A study conducted in the UK, shows that 48 percent of the waste that could be prevented in households was due to "not being used in time" and one third of the time this was due to date labels (WRAP, 2014).

**Supply chain collaboration.** The supply chain actors should work together to get a better understanding of the wastage that occurs in the chain and by collaborating among actors, new technology, such as active packaging, and information sharing can be used to reduce unnecessary or out-of-date stock (Verghese et al., 2013). Active packaging is when the product, package and environment interact to extend the shelf life, increase the safety features or strengthen the sensory properties of the product without affecting its quality (Suppakul, Miltz, Sonneveld& Bigger, 2003).

**Informative.** The different packaging levels should have appropriate information about e.g. amount, weight and destination, to avoid waste and damage of the product throughout the supply chain (Molina-Besch&Pålsson, 2016). For instance, it should say on the milk carton how end-consumers should store it at home for it to stay fresh as long as possible. Furthermore, by informing consumers, through packaging, about the correct methods regarding dosage and preparation of the food product, the waste can be reduced (European, 2014).

**User-friendliness.** The packaging of a product should be easy to use for consumers (e.g. easy to open and empty) to reduce product waste as well as for the people handling the product in the supply chain (e.g. easy to lift and carry) to reduce product damages (Molina-Besch&Pålsson, 2016). An example is shelf ready packaging that would reduce double handling and therefore decrease the risk of damage and increase the speed of the supply chain, which would in turn lead to less product waste (Verghese et al., 2013).

Finally, making changes to packaging designs that entail increasing the environmental impact, for instance adding more packaging material, is not necessarily a reason not to perform the changes. It is the total impact of changing the packaging design and reducing the food waste that needs to be taken into

consideration. If the reduced food waste results in decreasing the environmental impact more than the new packaging design increases it, then the new packaging design is a beneficial one from an environmental point of view. (Wikström & Williams, 2010)

### 3.3 Iceberg lettuce characteristics

The food item studied in this master thesis is iceberg lettuce which contributes to a large part of the total lettuce production in Sweden (Öhgren, Rådin, Ivarsson, Persson, & Ekerwald, 2003). The season for Swedish iceberg lettuce normally lasts from May to October (Grönsaksmästarna, n.d.). Iceberg lettuce is sensitive to high temperatures and is therefore suitable for northern climates (University of Illinois Extension, n.d.). The lettuce grows fast with a maturity time that varies between six and nine weeks (Öhgren et al., 2003). The compactness of the lettuce head determines its degree of maturity. A head is mature if it can be compressed with moderate force while it is over matured if it is very compact and immature if it is very loose. Over matured iceberg heads taste worse and have more postharvest issues than mature and immature heads (Cantwell & Suslow, 2002). Due to its sensitivity to heat, harvesting of iceberg lettuce should not be done in the middle of the day when it is hot outside. Harvested iceberg heads are trimmed, that is the outer leaves are removed, but it is important not to remove too many leaves because then the head will spoil faster (Öhgren et al., 2003). After the trimming, the remaining leaves should be crisp and a clear light green color, which indicates that the quality of the head is good (Cantwell & Suslow, 2002). The lettuce should be placed in a chilled environment straight after harvest to ensure its quality (Öhgren et al., 2003).

The optimal storage temperature for iceberg lettuce is 0 °C and the relative humidity should be higher than 95 percent. In these conditions, the shelf life would be between 21 and 28 days. If the lettuce would instead be stored in a temperature of 5 °C, then the expected shelf life would be 14 days provided that there is no ethylene in contact with the lettuce (Cantwell & Suslow, 2002). The rate at which ethylene is released depends on the temperature; the higher temperature, the more ethylene is liberated (Danish Technological Institute, 2008).

According to the WSU Tree Fruit Research and Extension Center (2017), ethylene is a gas naturally produced in plants and it causes the changes that occur in plants during ripening, such as alterations in texture and color. Different plants produce different amounts of ethylene and their sensitivity to the gas also varies. For example, apples and pears produce a lot of ethylene while blueberries and cherries hardly produce any (WSU Tree Fruit Research & Extension Center, 2017). Iceberg lettuce produces low amounts of ethylene but is highly sensitive to the gas. If the lettuce is in an environment that contains ethylene then russet spotting is likely to

occur. Russet spotting is a disorder that causes brown pigment spots to appear on the lettuce. The brown spots are mostly concentrated on the stem of the lettuce but in severe situations the spots can be found on the green leaves as well. An iceberg lettuce head with russet spotting is still edible and does not cause any health problems but because of the cosmetic changes in the lettuce, customers do not want to purchase it. Iceberg lettuce might come in contact with ethylene in mixed-load transports or in storage with fruits that produce high amounts of ethylene. (Cantwell & Suslow, 2002)

Iceberg lettuce is, like all other fruits and vegetables, still a living organism after it has been harvested and therefore its respiration continues in order to generate energy for its internal processes. The energy is produced from the breakdown of carbohydrates in the plant. Oxygen is required for the respiration to work and energy as well as water and carbon dioxide are outputs from the process. The respiration rate decides how perishable a fruit or vegetable is. The higher respiration rate, the more perishable the food is. The respiration negatively affects the flavor, sweetness, weight and water content as well as decreases the amount of nutrients in the plant. Therefore, by reducing a plant's respiration rate, its shelf life can be extended. One of the factors affecting the respiration rate is the temperature that the plant is stored in. The higher the temperature, the higher the rate of respiration (Silva, 2010). Different plants have different respiration rates and iceberg lettuce falls within the moderate range. (Cantwell & Suslow, 2002)

The respiration rate as well as the negative effects ethylene generates can be reduced by storing the lettuce in an area with specific conditions and thereby extending the shelf life (Cantwell & Suslow, 2002). These areas are called Controlled Atmospheres (CA) and the parameters that can be modified are the storage time, temperature, relative humidity as well as the amounts of O<sub>2</sub>, CO<sub>2</sub> and ethylene. Regarding lettuce, whole iceberg lettuce heads last longer in atmospheres with low concentration of both O<sub>2</sub> and CO<sub>2</sub> while cut lettuce requires low concentrations of O<sub>2</sub> but higher levels of CO<sub>2</sub> (Saltveit, 2001). High levels of CO<sub>2</sub> may cause brown stains in uncut lettuce while they lessen the browning of the cut parts when it comes to cut lettuce. The effects to the cut lettuce occur faster than for those to the uncut lettuce. (Cantwell & Suslow, 2002)

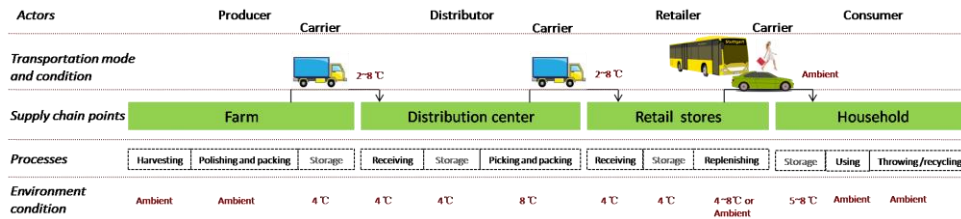
## 4 Results

*In this section, the information gathered from the interviews with the different supply chain actors will be presented. Firstly, the supply chain as well as the packaging system for iceberg lettuce will be explained based on the information received in the interviews. Then a deeper presentation of the results from each actor will follow.*

### 4.1 The supply chain and packaging system of iceberg lettuce

#### 4.1.1 The supply chain of iceberg lettuce

The supply chain map in Figure 5 illustrates all of the processes in each step of the supply chain of iceberg lettuce. The information in Figure 5 is obtained from the interviews conducted in this study. In production, after harvesting, iceberg lettuce is polished and packed in primary packaging by the producer (Producer 1, 2, 3). If the lettuce cannot be transported immediately, it will be placed in cold storage which has a temperature of around 4 °C (Producer 1). After that, the lettuce is packed in secondary and tertiary packaging before being transported by truck from the producer to the distribution center (Producer 1) or straight to the retailer (Distributor 2). The temperature in the truck ranges from 2 °C to 8 °C (Distributor 2). Most of the time, Distributor 2 picks up the products at the producer and drives them straight to the retailer while Distributor 1 stores the products in their distribution center before they are delivered to the retailers. After the iceberg lettuce is received at the distribution center it is placed in a cold storage, with a temperature of around 4 °C, for a short period of time (Distributor 1). The temperature in the trucks delivering products to the retailers varies depending on the requirements from the different retailers. Most often the temperature is between 2 °C and 8 °C (Distributor 1, 2) but it can also be above 8 °C (Distributor 1).



**Figure 5** The supply chain of iceberg lettuce (Mansner & Wang, Personal figure, 2017).

The retailers receive deliveries of iceberg lettuce every day (Retailer 1, 2, 3, 4). Depending on the amount on the shelves, the lettuce is either placed immediately on the shelves (Retailer 2, 4) or it is placed in a cold storage room. Retailers 1 and 3 do not have a cold storage room and therefore they always place the lettuce immediately out on the shelves. The temperature on the shelves depends, two of the retailers use cold temperatures of around 4 °C to 8 °C for iceberg lettuce (Retailer 2, 4) while the other two retailers have ambient temperatures (Retailer 1, 3). The iceberg lettuce stays in the stores no longer than two days (Retailer 1, 2, 3, 4). In the last stage of the supply chain, consumers bring home the lettuce by bus, car or walking and in the households they store it in the fridge (All consumers).

#### 4.1.2 The packaging system for iceberg lettuce

The packaging system is different from case to case but the majority of the iceberg lettuce sold in Sweden has a primary packaging (Retailer 2, 3, 4). The examples of different primary packaging can be seen in Figure 6. In some cases, the iceberg lettuce produced in Sweden can come without primary packaging (Retailer 2). The primary packaging consists of a perforated transparent plastic bag that is sealed with tape. The perforation prevents condensation which has a damaging effect on the quality of the lettuce (Producer 1).



**Figure 6 Examples of different types of primary packaging for iceberg lettuce (Mansner & Wang, Personal photos, 2017).**

The primary packages are put in secondary boxes to facilitate the handling of the iceberg lettuce from producer to retailer. The secondary packaging usually consists of either an open cardboard box or a returnable SRS (Svenskareturnsystem) container (Producer 1, 2 and Retailer 1, 2, 3, 4), which can be seen in Figure 7. Additional material, such as well plastics, is sometimes added to increase the protection of the lettuce (Producer 2).



**Figure 7The left photo shows a plastic returnable container and the right photo shows a cardboard box (Mansner & Wang, Personal photos, 2017).**

The tertiary packaging for iceberg lettuce varies as well. Most often pallets or roll containers are used (Retailer 1, 2, 3, 4). Roll containers are easy to roll off a truck into a retail store (Producer 3).

## 4.2 Food waste and packaging in the supply chain

In this section, the information about food waste and the packaging system that was received from the interviews will be presented actor by actor.

### 4.2.1 Consumers

#### 4.2.1.1 Food wastage

##### **Consumers' opinions on food waste**

All of the interviewed consumers believe that food waste is a problem. However, four consumers (Consumer 1, 4, 9, 15) say that food waste is not a problem for them personally. Take an example from Consumer 1, *“It does not feel that good. It is a waste of the resources of the planet. [...] It is more a problem for the society than for each individual. [...] I can afford to waste food, but you do not want to do that.”*

Most interviewees think food waste is a problem because it has a negative impact on the environment and it is a waste of resources (Consumer 1, 3, 4, 5, 6, 7, 8, 12, 16, 17). A large part of the consumers also say wasting food is a problem when there are people starving in the world (Consumer 4, 5, 6, 10, 12, 13, 14, 15). Six interviewees point out that it is a financial loss to waste food (Consumer 2, 3, 12, 14, 16, 17) but they often add that this is not the main problem with food waste. The majority of the consumers note that they feel guilty or bad in some way when they throw away food (Consumer 1, 2, 3, 4, 5, 6, 9, 10, 11, 13, 16, 17): *“I feel guilty when I throw away food and I know children go hungry in other parts of the world.”* (Consumer 13).

##### **Reasons for food waste in households**

Most consumers acknowledge they waste food (Consumer 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17) and ten out of seventeen interviewees say they throw away food on a daily basis (Consumer 2, 3, 4, 6, 7, 8, 9, 10, 14, 15). The consumers that say they rarely or never throw away food give different ideas for why this is. Some mention this is because they think food wastage is not sustainable and they try actively to reduce their wastage (Consumer 1, 12, 13, 16, 17). One consumer notes that she is good at cooking and knows how to use all food (Consumer 5) and another considers it is because she grew up during war-time and therefore learnt to never throw away food (Consumer 11).

The food products consumers throw away the most are fruit and vegetables (Consumer 1, 2, 3, 4, 6, 7, 8, 9, 10, 14, 17) as well as bread (Consumer 6, 10, 14, 16). The reasons the consumers give for throwing away food vary but the most common reasons are forgetting or keeping the food in the fridge too long which results in the food becoming inedible (Consumer 1, 3, 4, 6, 7, 8, 10, 14, 15) and



buying too much food that they are not able to consume (Consumer 3, 4, 6, 8, 11, 14, 15, 17). The latter reason is expressed by Consumer 17:

*It is probably because it is not a perfect match between planning and execution when it comes to cooking food. Maybe it is some food that we have bought a little too much of. Perhaps the package is 400 grams but we only need 300 grams and then we save the leftovers so that we can maybe use them later but in cases where we can't, the food spoils sooner or later. (Consumer 17)*

Other reasons for throwing away food given by the interviewees are cooking too much and then throwing away leftovers (Consumer 3, 7, 8, 10, 12), not being able to use all food when cooking (Consumer 3, 9), too large packages (Consumer 2, 17) and the food being unhygienic (Consumer 9). Consumer 10 points out the difficulty of cooking the right amount of food:

*It is probably because there are a lot of leftovers. [...] It is probably me that cooks too much. The children are here every other week but sometimes they show up at other times too and then it is hard to know how much to cook so that is why I often cook too much. Especially potatoes and they are not nice to save so I often throw away food like that. (Consumer 10)*

Regarding when the consumers think about food waste in their daily life, the interviewees note that they think about it when wasting food or taking out the trash (Consumer 3, 6, 7, 9, 10, 15, 16), when grocery shopping (Consumer 1, 4), when cooking (Consumer 5, 8) or when they have leftovers from cooking or eating (Consumer 6, 10).

### **Reducing food waste in households**

Concerning the consumers' actions to reduce their food waste, the majority of the interviewed consumers say they try to plan their food shopping and only buy what they know they will be able to consume (Consumer 1, 3, 4, 7, 9, 11, 12, 15, 16). Some consumers point out that they check their fridge often to be able to ensure the food is used before it expires (Consumer 2, 8, 10, 16), try to store the food in a good way in order to make it last longer (Consumer 2, 11), cook smaller portions they know they will be able to finish (Consumer 1, 7) or make use of leftovers instead of throwing them away (Consumer 6, 12). Two consumers (Consumer 10, 17) admit they know how they could further reduce their food wastage but they choose to not do so: *"I tell myself I do not have the time but in reality it is probably just a bad excuse."* (Consumer 17). Consumer 10 also mentions lack of time being a significant factor: *"I know I could cook three times per day. [...] But I do not have enough time to do so. But I guess I could if I really tried."*

Consumer 17 uses trash bags for food that are made of degradable plastics and the food in this bag will be recycled into biogas. He likes the bag because it takes care of the food waste in a better way than normal plastic bags. However, he is worried that it makes people feel that it is acceptable to waste food when they know it will be handled in a good way.

Also, four consumers (Consumer 6, 7, 8, 17) mention the connection between a product's price and its waste. Consumer 6 says the availability rather than the price of a product is important to her when trying to prevent food wastage. For instance, if the product is difficult to get hold, such as foreign products, she would try harder than with easily accessible products to waste as little as possible. Three of the consumers (Consumer 7, 8, 17) believe they try harder to prevent expensive products from being wasted, through better planning of shopping and consumption, than cheap products. Like expressed by one consumer, "You are aware of that fact and do not want to waste your own money." (Consumer 8).

### **Iceberg lettuce**

Concerning the buying and usage of iceberg lettuce, the interviewed consumers choose iceberg lettuce by visual cues. The freshness is the most important factor (Consumer 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 13, 14, 16, 17). Three consumers mention that they will choose not to purchase iceberg lettuce if it does not look fresh enough (Consumer 2, 11, 17):

*If it does not look fresh then I do not buy it. [I am] aware that this increases the risk of waste somewhere else. [...] But if grocery stores would divide the products into first- and second-rate with different price tags then I would consider buying the one that looks a little tired if I plan to use it soon. (Consumer 17)*

Many consumers also consider the size when buying iceberg lettuce. The majority prefers smaller-sized lettuce because then they are more likely to be able to finish the lettuce before it expires (Consumer 1, 6, 7, 8, 9, 13, 14). Some consumers select the lettuce based on its weight. The weight preferences vary, some consumers prefer light-weighted lettuce because they believe it is fresher and the leaves are easier to separate (Consumer 2, 11, 16) while others prefer heavier ones because they are firmer (Consumer 10).

When at home, all interviewed consumers store iceberg lettuce in the fridge. All interviewees mention that they waste iceberg lettuce at one time or another. They throw away lettuce when the quality of the lettuce reaches a level the consumers consider inedible. If only parts of the lettuce are considered inedible then the consumers only remove these parts and keep the remaining lettuce. The root and the outer leaves are the parts of the lettuce that are mentioned most often as being thrown away (Consumer 2, 3, 6, 7, 13). Two consumers (Consumer 6, 16) do not consider the root when they are asked what parts of the lettuce they throw away, but when questioned specifically about the root they admit that they do throw it away. Regarding what could make the consumers throw away less iceberg lettuce, the most common factor is a longer shelf life (Consumer 1, 2, 7, 8, 9). Smaller-sized iceberg lettuce (Consumer 5, 6, 8) and eating more (Consumer 10, 15, 16) are other mentioned influences. One of the interviewees (Consumer 4) notes that a best-before-date would be useful as a reminder to use the lettuce as soon as possible.

### **The largest waste contributor in the supply chain**

When asked where they think the largest food wastage occurs, three consumers (Consumer 2, 6, 7) mention the households as the greatest waste contributor. However, the majority of the consumers (Consumer 1, 3, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17) believe that retailers and restaurants contribute the most to the total food waste. Consumer 3 has worked in a restaurant and according to him, the restaurants throw away large amounts of food. Consumer 14 and 15 note that since the retailers handle large quantities of food, they must have a lot of waste as well. Consumer 4 and 5 say that because they have heard on the news that homeless people eat the garbage from retail stores and restaurants, they think these actors generate large amounts of food waste. Consumer 7 believes the producers generate the most amount of waste because the strict quality requirements may lead to food waste, for instance the product is not in a good shape and have to be thrown away. Consumer 4 considers the distributors to contribute the most to the wastage because she thinks it must be difficult to distribute large quantities of food and maintain a good quality.

#### *4.2.1.2 Packaging*

When it comes to packaging, the majority of the interviewed consumers consider packaging necessary in many cases in order to protect the food (Consumer 1, 2, 3, 6, 7, 10, 11, 13, 14, 15, 17). For instance, Consumer 10 cannot think of a way to handle milk without packaging. However, some of the consumers point out that too much packaging is used in today's society (Consumer 1, 2, 4, 8, 11, 12, 17):

*I think they are good from a hygienic point of view. Some things, such as sausages, were sold unpacked before and it was not always hygienic. You did not know how long they had been lying there. Then it is good to have it packed in vacuum. (Consumer 2)*

*A lot of the time there is too much packaging, [such as] double packaging. Both a firm carton and then a plastic bag inside just to make it look more exclusive. From a business point of view I can understand the packaging; you can increase the price with more than the packaging costs. But it is pretty stupid to double pack. So it is not optimal. (Consumer 17)*

Regarding packaging for iceberg lettuce, the majority of the consumers claim they do not like the primary packaging (Consumer 1, 2, 3, 4, 6, 7, 8, 10, 12, 13, 14, 15, 16) even though some of them believe it protects the lettuce well enough from its surrounding environment (Consumer 6, 2, 12, 13, 15). Many consumers remove the iceberg lettuce from the original primary packaging in the household and place the lettuce in a new plastic bag (Consumer 1, 2, 4, 8, 10, 11, 13, 14, 16). They do this because the bag either breaks when opening it which makes the bag hard to reseal (Consumer 1, 2, 7, 9, 10, 14, 15) or the bag is dirty (Consumer 2, 10, 11). Consumer 13 removes the bag because she claims the iceberg lettuce needs more air than it receives in the original bag in order to breathe properly. Consumer 10 believes that if the bag were re-closable, then the lettuce would last longer.

Moreover, Consumer 12 points out that she would prefer to buy iceberg lettuce without any primary packaging at all even though she is aware of the fact that packaging probably prolongs the shelf life of lettuce. Consumer 8 does neither like packaging in general nor the packaging for iceberg lettuce: *“It would be quicker without any package, it is unnecessary to use time to open the package.”*

The interviewees are asked whether or not they would be willing to pay more for a better packaging quality for iceberg lettuce. Ten consumers (Consumer 2, 4, 6, 8, 9, 11, 13, 14, 15, 16) answer they would be willing to pay more but nine of them (Consumer 2, 4, 6, 8, 9, 11, 14, 15, 16) would only be willing to pay a small amount more, which is less than 10 percent of the whole price. The rest (Consumer 1, 3, 5, 7, 10, 12, 17) are not willing to pay more for improved packaging and one consumer states *“If the price becomes more expensive, I will just buy other products.”* (Consumer 5). The main reasons for the refusal to pay more are that the consumers care more about iceberg lettuce itself rather than the packaging or they think the current package is good enough.

## 4.2.2 Retailers

### 4.2.2.1 Food wastage

#### **Reasons for food waste in retail stores**

All four interviewed retailers regard waste as being a large problem in the food industry and they claim they endeavor to reduce their own food wastage. According to them, one of the main reasons for food waste at the retail part of the food supply chain is consumers' high product requirements (Retailer 2, 3, 4). Today's consumers have high requirements and standards on food products. They want the products to look good and be fresh. To illustrate, if a product has a little brown spot then the consumers will not buy it even if the defect does not affect the edibility of the product (Retailer 2). This leads to the product being wasted. Retailer 1 note that the manner in which iceberg lettuce is placed on the shelves in the store is important for its quality and thus how much is wasted. If the lettuce is piled on top of each other it might look appealing to the consumers but the lettuce in the bottom would get crushed and then thrown away. She also stresses that it is crucial to replenish from the bottom so the oldest products are on top to facilitate a “First in, first out” flow of products.

Retailer 3 considers consumers to be too rigorous with best-before-dates. He points out that they want the longest possible date and therefore the products with short dates are left in the store and then eventually wasted. Retailer 4 believes consumers choose the products that look the most fresh or have the longest best-before-date because they want the product to last as long as possible in the household. Retailer 3 states that because of legal requirements they cannot sell food products that have expired. He considers the laws to be too strict because they force stores to throw away food that is still edible.

Another reason for food waste in retail stores is too large order quantities (Retailer 2, 3, 4). Retailer 4 says since fruit and vegetables are perishable it is important to order the correct amount. If they order more than they sell then the leftover products will eventually become defect and unsellable and finally wasted. To try to ensure they never order too much, Retailer 3 always checks how much they sold the previous day before placing a new order.

Retailers 1 and 3 note that the largest part of iceberg lettuce waste occurs in-store rather than pre-store. Retailer 1 claims that the distributor checks the quality of the iceberg lettuce before sending it to the retailer. The retailer and distributor belong to the same company which makes having a good lettuce quality important for both actors. According to retailer 3, the in-store waste is higher than the pre-store waste because the lettuce stays too long in the store or that quality issues are not detected in the pre-store quality control due to the fact that mold usually starts from the inside of the lettuce which makes it hard to spot.

Other reasons for food wastage in the retail stage of the supply chain are products' fragility (e.g. fruits and vegetables are sensitive to high temperature) (Retailer 3), damaged packages (Retailer 1) and far-away suppliers which means long transportations which in turn lead to shorter remaining shelf life of the products when they reach the retailer (Retailer 2).

Retailer 2 states that consumers demand most products year-round and they have high requirements on product quality even during off-season periods. During the summer when iceberg lettuce is produced in Sweden, its quality is higher and for that reason, they throw away less lettuce in the store. However, since consumers also demand iceberg lettuce when it is not in season, retailers have to import it. Imported iceberg lettuce requires a longer transportation which means a higher risk of product damage and a shorter remaining shelf life when arriving to the retail stores. These factors contribute to more food waste.

Uncontrollable factors, such as the weather, also affect the production and quality of iceberg lettuce according to Retailer 2. If the weather is bad then the lettuce production might suffer. This happened in January 2017 when the Mediterranean area was struck by bad weather which led to a decrease in the amount and the quality of lettuce being produced. Consumers still demanded iceberg lettuce in Sweden but when the price increased and the quality declined then consumers chose not to purchase the lettuce, which led to an increased in-store wastage.

### **Reducing food waste at retailers**

Retailer 1 and 4 mention that they are or are planning on collaborating with organizations that collect food that the retailer cannot sell due to expired best-before-dates or quality defects but that is still edible and donate it to people in need.

Retailer 2 states that from a food waste point of view it is better to collaborate with small local suppliers because they usually have a short supply chain and therefore

more of the product's shelf life remains when it reaches the store. For instance, Swedish iceberg lettuce is usually harvested one or two days before it arrives to the retailer while it takes Spanish lettuce four to five days to reach the retailer. Retailer 2 points out that Swedish iceberg lettuce therefore lasts longer in the store than Spanish lettuce. Retailer 4 also notes that shorter supply chains lead to longer shelf life of iceberg lettuce in the store. Retailer 2 prefers local suppliers to far-away ones, but according to him, the problem with local suppliers is that they are usually small and then a large number of suppliers are needed to cover the store's product demand. Having many different suppliers means more relationships to maintain and more contacts to handle. This in turn leads to more work and that is a significant reason for why Retailer 2 does not work with only local suppliers.

Sometimes it is more economically beneficial for retailers to waste food rather than try to prevent it. For instance, Retailer 2 says that reducing the price on the heads of iceberg lettuce whose shelf life is about to expire requires workers to identify these and mark them which cost more money than they would receive from selling the lettuce to a reduced price. Thus, they choose to always sell the lettuce at normal price and then throw away the heads that are unsellable. Retailer 2 adds that it is not profitable for them to reduce the price on all heads of iceberg lettuce, which would reduce the extra work needed, when some of the lettuce is about to expire. He thinks it is better to evaluate the order quantities to ensure they do not order more than they will be able to sell before the quality of the iceberg lettuce makes it unsellable. However, Retailer 1 has another approach which means they reduce the price of the unsold products at the end of the day to prevent products from going bad. Retailer 4 says it is sometimes easier to throw away food than having an employee using time and money to do something that can reduce food waste.

None of the interviewed retailers considers their wastage of iceberg lettuce to be a problem. Retailer 4 believes that food waste is inevitable for retailers since they need to always provide safe and good quality food to the consumers.

### **The largest waste contributor in the supply chain**

All of the retailers consider the consumers to be the supply chain actor that waste the most. They claim it is because consumers buy too much food that either they cannot finish or they do not have planned to use, which is expressed by one retailer:

*Usually, I think stores today have a high standard in Sweden and that is why when you go into a store you are like "oh this looks nice, I have to buy it". But you don't think "okay I will use this for this and that for that". It is a good thing for us because we make money doing that but when it comes to food waste it is not a good thing. (Retailer 2)*

#### 4.2.2.2 Packaging

Regarding packaging, according to Retailer 4, the primary packaging keeps the iceberg lettuce hygienic so that consumers want to buy it. Around 20 years ago, the iceberg lettuce was not packed but Retailer 4 thinks that the fact that primary packaging is used today is good because it extends the shelf life of the lettuce. This contributes to less food waste because more lettuce can be sold before it spoils. Retailer 1 points out that it is important that the packages are cheap as well as easy to handle in order for their operations to be fast. All interviewed retailers are satisfied with the primary packaging for iceberg lettuce and the majority mention that they prefer packed to unpacked iceberg lettuce because it protects the lettuce. Retailer 2 and 3 state that Swedish iceberg lettuce does not always have primary packaging but they want it since they deem there will be too much food waste if they do not. Also, it is important to consider the consequences of removing packaging:

*If it is not in a bag, then you take a bag. It is the same for iceberg lettuce. Had it not already been in a bag, then the customers would take a plastic bag and put it there. So the question is what you benefit most from? If it is not delivered [to the store] in a bag then there will be damages and we have to throw away more. The bag the customers would put the lettuce in could potentially contain less plastic. On the other hand, the waste is bigger. [...] What do we benefit most from? Honestly I think having the lettuce in a bag from the beginning because then it does not go bad.*  
(Retailer 1)

Even though the retailers regard food packaging has having improved recently, most of the retailers believe there is still room for improvement concerning the amount and type of packaging material used for food products in general (Retailer 1, 2, 4). However, Retailer 4 points out that packaging can reduce food waste for some products and this needs to be taken into consideration when changing packaging.

Retailer 1 uses cardboard boxes as secondary packaging and she claims that there is no crushing when stacking the boxes on top of each other because the boxes are higher than the lettuce itself. Retailer 1 also mentions that there is no moisture damage to the boxes because the boxes are never left outside. According to her, the secondary packaging does not affect the amount of iceberg lettuce that is wasted. Retailer 2, 3 and 4 use both cardboard and plastic boxes as secondary packaging for iceberg lettuce and Retailer 2 notes that there is rarely any damaged to the lettuce because of the boxes. Sometimes an employee can crash into something with a box which can cause product damage and wastage but according to him, this is not a significant problem. Retailer 2 and 3 prefer plastic boxes because they do not generate waste and are therefore more environmentally friendly.

#### 4.2.2.3 Package-free shops

Two retailers with a package-free concept were interviewed in this study. They sell their products in bulk and thus have no primary packaging. Retailer 5 explains that the package-free concept started with her trying to reduce her personal wastage in every aspect of her life. She became extremely frustrated with food packaging because oftentimes the food was over-packed. In order to change the situation she decided to open her own package-free shop. Retailer 6 mentions a similar journey. The founder tried to become more environmentally friendly and healthier but became discouraged when he realized how much packaging is used for food products. He then decided that if he wants to notice a change in the packaging consumption, he needs to make it himself.

None of these two shops sell iceberg lettuce at the moment. Retailer 6 sells other vegetables but has not been able to find suppliers that offer package-free iceberg lettuce. However, they are hoping to find package-free iceberg lettuce during the summer when the local iceberg lettuce production occurs. Retailer 5 does not currently sell any fruits or vegetables and the owner points out that they need to do research about iceberg lettuce to see if it would be applicable to the package-free concept.

#### 4.2.3 Distributors

##### **Reasons for food waste in distribution**

Distributor 1 believes that the temperature is the most important factor in maintaining a good quality of iceberg lettuce. She highlights that *“as long as it is cold temperature, the quality of iceberg lettuce will be good”*. Concerning the size of iceberg lettuce, Distributor 1 notes that in the beginning of the Swedish season for iceberg lettuce, a smaller lettuce size can be expected. In the middle and end of the season, the size depends on what is left and what is demanded. According to UN norms, iceberg lettuce needs to be of a certain size and to be of equal in the same secondary box. For instance, it is not allowed to have a small- and large-sized lettuce in the same box. Normally retailers require a minimum weight of 300 grams per iceberg lettuce. The food waste occurring at Distributor 1 is mostly due to lettuce not following this specification. If possible, Distributor 1 sells the lettuce as a lower class or to other markets. The remaining unsold iceberg lettuce becomes biogas. Food waste can also stem from diseases affecting the iceberg lettuce and its quality. Here the primary packaging plays an important role in preventing the disease from spreading from the infected lettuce to the other heads in the same secondary packaging.

##### **The impact of transportation on food wastage**

In the interview with Distributor 2, the interviewee declares that the secondary packaging is important in reducing food waste and the interviewee believes most



other supply chain actors are not aware of how significant a role the secondary packaging plays. Most transports Distributor 2 perform involve trucks containing many different products. This they do to reduce the number of transports needed and to be able to reach more remote locations which would not be profitable if each truck was dedicated to one product only. However, these mixed transports are problematic, especially for iceberg lettuce and vegetables in general that consist of a high ratio of water. The problem lies in the transport temperature, which ranges from 2 °C to 8 °C for cold products. The cooling unit in the truck is set to a certain temperature, e.g. 2 °C. If the truck transports products that hold a warmer temperature, e.g. 6 °C, then the air coming from the area where these products are placed will be higher than 2 °C and when the cooling unit detects this it will start blowing out air of negative temperature. Most of the time the iceberg lettuce is packed in a cardboard box which is placed on top of the products in the truck because the box is usually open and then nothing can be stacked on top of it. The cold air that the cooling unit is blowing out to compensate for the warmer air will then freeze the iceberg lettuce if it does not have proper packaging protecting it. When iceberg lettuce freezes it becomes unsellable and therefore wasted.

To protect the iceberg lettuce from temperature differences, additional packaging material, such as corrugated cardboard or plastic, can be used. For instance, open cardboard boxes would benefit from having a protecting layer of material to cover the opening. It is important that there are holes in the packaging material to allow air to circulate. However, too large holes should be avoided to prevent cold air from seeping into the package. It is important to ensure the iceberg lettuce does not become too warm or too cold. Corrugated board is suitable for iceberg lettuce because it maintains warmth at the same time as it does not overheat the lettuce. From a distribution perspective, the returnable plastic containers are preferred over cardboard boxes because they are more stable and hence do not need to be placed on top of the other products during transport which protects the products better from temperature fluctuations. When using returnable plastic containers, extra packaging material is needed to protect the iceberg lettuce from the large holes in the containers. (Distributor 2)

A more advanced cooling unit that allows for temperature adjustments can help in protecting the iceberg lettuce from temperature differences during transport but it is expensive and according to Distributor 2, no one is willing to invest in it. Therefore, Distributor 2 believes packaging that better protects the product is a more realistic and cheaper solution. Nevertheless, the interviewee claims it is difficult to convince the other supply chain actors to invest in packaging because they view it more as an added cost and they do not realize its benefits:

*Packaging is an extremely important parameter when looking at the costs generated by lacking quality. How much does not biddings cost? How much does it not cost to scrap a product that was perfectly fine but the packaging did not protect it from the minus degrees it was exposed to? (Distributor 2)*

### **The largest waste contributor in the supply chain**

Regarding the question of who wastes the most in the supply chain, Distributor 1 considers producers and retailers to have the largest opportunities for significant losses and therefore contribute the most to the food wastage.

#### 4.2.4 Producers

##### 4.2.4.1 Food wastage

###### Reasons for food waste in farms

All three producers that are interviewed regard the temperature as the most important factor in maintaining the quality of iceberg lettuce. The lettuce should be kept cold, preferably in 3 °C to 4 °C according to Producer 1. Furthermore, Producer 1 points out that the lettuce is not sensitive to light or sunshine as long as the lettuce remains cold. Producer 2 mentions that having iceberg lettuce in room temperature in grocery stores is not good for its quality. She also claims that Swedish households have too high temperatures in their fridges, around 7-8 °C, which also affects the lettuce quality negatively. Furthermore, Producer 2 adds that it is not the temperature itself that is the most important factor in maintaining a good lettuce quality but keeping an even temperature level devoid of any fluctuations:

*If you have 8 degrees in your fridge, you think it's maybe better than 16 degrees, but sometimes it is 5 then 8 degrees and then 5 degrees again. Then it is much more harmful than 16 degrees day and night. [...] The [temperature] variations make it more complicated. (Producer 2)*

Producer 3 also considers temperature changes to have a negative impact on lettuce. When consumers purchase the lettuce and bring it home, the lettuce is most likely not kept cold which affects its quality. However, he states that how the consumers handle the lettuce is not his responsibility. According to Producer 2, another factor affecting the quality of iceberg lettuce is moisture. The lettuce prefers moist air and the interviewee thinks the atmosphere in the household fridges is not optimal. The lettuce would benefit from being in an environment with only vegetables and not with other products that breathe and contaminate the air.

The interviewees point out some factors during the production operations that affect the quality of the iceberg lettuce and therefore how much is wasted. The Swedish iceberg lettuce is harvested during the summer, which is the warmest period of the year. Because lettuce is sensitive to warm temperatures, Producer 3 discloses that they harvest the lettuce in the evenings when the air is cooler. However, if it has been warm and sunny during the day then the lettuce is probably warmed up and needs to be cooled down before being packed. This they do by putting the lettuce in water baths. If the lettuce is packed while still warm, there will be condensation inside the package and the lettuce will rot. Producer 3

also notes that if the harvested lettuce is left out in the sun without packaging then it turns soft quickly which equals poor lettuce quality.

All interviewed producers have some waste of iceberg lettuce. Producer 1 declares that when planting the lettuce, 5-10 percent of the plants are damaged or do not grow properly and therefore become waste. Producer 1 points out that they always produce more lettuce than they think will be consumed in order to be able to satisfy unexpected demand. Also, the interviewee mentions that a lot of lettuce is harvested even though there is no demand for it because they have workers that need to get paid. Another factor Producer 1 regards as a contributor to the wastage is the machines they use during production. They have 400 hectare of lettuce which makes it cheaper and faster to use large machines rather than human workforce. On one hand, the machines run over some of the lettuce and thus damage it but on the other hand, workers become tired and make mistakes which also lead to damages to the lettuce.

Producer 1 believes the most important reason for iceberg lettuce waste during production is pests or vermin. Nonetheless, they attempt to use as little pesticides as possible, both for economic reasons as well as to protecting the soil. Producer 2 mentions that in the end of the lettuce season they can have problems with fungus which damages the lettuce. According to Producer 3, there is a “polish waste” which occurs when the dirty or bad outer leaves are removed from the lettuce after harvest. He also mentions that if they do not water properly, for instance they water too much or too little and at the wrong moment, the lettuce can develop tip burn which causes the edges of the leaves to turn brown. The ambition is to harvest all the good lettuce but that is unfortunately not always the case. They might leave good lettuce in the field if the actual demand does not fit the forecasted demand. It costs money to harvest so if they know they cannot sell the lettuce then Producer 3 claims it is more beneficial economically for them to let the lettuce go to waste.

### **The size of iceberg lettuce heads**

Producer 1 explains that they can determine the size of the lettuce heads by controlling the time they cut them. The ones that they cut early in the season are smaller than the ones they cut later. They might cut a field at three different times and then the customer decides what size he wants. There are producers that cut 150- and 200-gram heads but Producer 1 thinks it is better to wait and let the lettuce grow into 400-gram heads. This way he will earn more money because the lettuce is sold per kilo. Producer 3 states that they have to follow EU norms for iceberg lettuce that put requirements, for instance regarding weight, on the lettuce in order to facilitate its trading.

### **The largest waste contributor in the supply chain**

Out of all supply chain actors, Producer 1 considers the households to be the most significant waste contributor:

*I think the biggest waste is generated by the consumers. I want of course the consumers to buy lettuce but I know from personal experience how it is. You use half a head of iceberg lettuce for your tacos on Friday and then you forget about the rest of the lettuce until Wednesday the next week and then it is not as fresh anymore. (Producer 1)*

Producer 3 also believes the households generates the largest amounts of waste together with food producers. He thinks consumers purchase too much food that they are not able to finish before it perishes. Also, due to the fact that producers have to overproduce to hedge against uncertainties such as a fluctuating demand, he supposes producers contribute to a large part of the total food waste. However, large amounts of the waste generated by food producers are returned back to the earth which is good according to Producer 3. Nevertheless, he adds that it is still a waste since it had the potential to become food.

#### *4.2.4.2 Packaging*

The producers of iceberg lettuce adapt the primary packaging to the buyers' requirements. Producer 3 mentions that they only deliver package-free lettuce if they know they will sell it straight to the consumer the day after it is harvested. If the supply chain would be longer, they would need to package the lettuce to protect it and extend its shelf life.

Producer 1 and 3, say that they use more and more returnable plastic containers as secondary boxes for their products. According to Producer 1, these containers are easier to handle than cardboard boxes because the cardboard can get wet and then the boxes risk breaking. This could in turn damage the products inside the boxes and potentially lead to food waste. However, the problem with returnable containers is that they are expensive (Producer 1) and the actors using them need to have space to store them (Distributor 2). It is the actor buying the iceberg lettuce from the producer that decides what secondary packaging should be used (Producer 1, 2).

# 5 Discussion

*The food waste problem is indeed a complex problem that concerns all different actors throughout the food supply chain. Today, there is a range of reasons why food waste exists and in certain cases wastage is inevitable. However, the results in this thesis show that there are several challenges present in the quest to reduce food waste but also opportunities for development and improvement.*

## 5.1 Consumers' behaviors and requirements

As seen in the third chapter of this thesis report, Aschemann-Witzel et al. (2015) suggest that consumers' concerns, awareness and behaviors affect their food wastage and the results received in this thesis show that the consumers lack incentives and motivation to reduce their food wastage. Also, the challenges and opportunities of consumers' requirements on year-round products, high product quality and less packaging related to food waste, are described in this section. Other consumer requirements, such as small-sized iceberg lettuce and long shelf life will be touched in section 5.2.1 and section 5.6.3, respectively. The results regarding the impact of consumers' quality requirements on food waste, cohere with previous research by Gunders (2012).

### 5.1.1 Lacking motivation

The results show that consumers are aware of the fact that food waste exists and they consider it a problem but they still generate waste they know how to avoid. For instance, Consumer 10 admits that if she would cook more often she could reduce her food waste but that she chooses not to do so because of laziness. Therefore, there is an opportunity to increase the motivations and incentives among consumers related to preventing food waste. This could be done by increasing consumers' understanding for how wasting food affects their personal lives. For instance, buying food and then throwing it away is a waste of the consumers' money and consumers might not be aware of how much money they waste by throwing away food. Being faced with the direct consequences of food wastage might serve as a wake-up call and motivate consumers to work harder to reduce their food wastage.

### **5.1.2 Lacking knowledge and awareness**

People's knowledge affects how they act and what people consider unavoidable food waste affects how much they waste. If consumers consider a certain part of a food product to be waste, that part will most certainly be wasted. During the interviews, it becomes clear that some consumers consider the root of an iceberg lettuce head to be unavoidable waste while a smaller group of consumers say they eat the root and think it is part of the edible components of the lettuce. This phenomena could be true related to other products and therefore have a notable impact on the total food wastage. Everyone has different habits of eating food, which is inevitable and hard to change but making consumers realize that what they are wasting is actually edible is important in order to prevent unnecessary food waste. Furthermore, informing consumers about what they can do with these food parts can provide helpful motivation to use all edible parts of a food product. For example, potato peel can be roasted and eaten as chips.

Additionally, consumers' awareness of food waste might also affect their wastage. The majority of the interviewed consumers think of food waste when wasting food or taking out the trash. Other less common occasions are when grocery shopping, when cooking and when being confronted with leftovers. These results indicate that consumers might have a reactive approach to food waste, that is, they think about food waste when encountering the problem. A small part of the consumers consider food waste when purchasing the food, that is, they have a proactive approach since they think about food waste before it has occurred. In order to drastically reduce the food waste, it is important to prevent the waste from appearing rather than handling it when it is present. Thus, it is crucial to generate awareness about the food waste problem already in the initial stages of the food consumption process, such as the planning and buying of the food. For instance, if consumers are aware of the food waste problem when grocery shopping then they might be more likely not to purchase too large packages just because the price per weight unit is lower than for smaller packages.

### **5.1.3 Year-round product availability**

The fact that consumers demand most products year-round affects the food wastage because products need to be imported during the periods they are not produced in Sweden. Take iceberg lettuce as an example, it is produced in Sweden during the summer season and the rest of the year it is imported from warmer countries such as Spain and Italy. The supply chain becomes hence longer during the off-season and then it is more difficult to maintain a good product quality. Retailers could stop selling certain products during their off-seasons but if other stores offer these products then consumers would go there instead and the retailers not selling the products would lose customers. For this concept of only offering products according to season to work, all retailers would need to adopt the same

concept. This is not considered realistic in today's globalized world and therefore, the challenge is instead to either endeavor to affect consumers' behaviors and mindsets so they realize that it is more sustainable to buy products according to season or attempt to provide off-season products with good quality. The second option would be a challenge for the whole supply chain to undertake, while the first alternative is focusing on the downstream part of the supply chain. Through education, consumers' awareness of how their consumption affects the environment and the food wastage might increase.

#### **5.1.4 High product quality**

Consumers have nowadays high demands on the quality of the food products they purchase which means that there is a considerable risk the products whose quality is lacking will become waste because they are unsellable.

The results in this thesis show that consumers select the iceberg lettuce head that looks most fresh and appealing to the eye. This means that consumers will leave the older and more tired-looking lettuce on the store shelves in favor of better-looking lettuce and the old lettuce will eventually spoil. The same challenge applies to food products with best-before-dates. Consumers want the best dates to ensure the product lasts as long as possible in the households. The fact that the "first-in, first-out" rule does not consistently apply is a difficult challenge for retailers and there exist coping mechanisms such as always replenishing in a manner that places the oldest products closest to the consumers. Furthermore, consumers prefer fruits and vegetables to look a certain way, such as having a specific shape, and if the product deviates from these requirements the consumers will not purchase them and they are wasted. However, in order to make a significant difference, the consumers need to be made aware of the importance of purchasing products that are not perfect but still completely edible. For instance, if the consumers know they will use a product soon after buying it, they might choose one with a shorter best-before-date rather than the longest best-before-date possible. Also, Retailer 3 has started a food waste reduction project where they sell imperfect fruit at a reduced price.

Regarding iceberg lettuce, its quality is affected by a range of factors including weather, pests, packaging as well as how it is transported and stored. One of the most difficult challenges for the whole supply chain is thus to maintain a good lettuce quality through all stages from production to consumption. This is not only true for iceberg lettuce but for all perishable food products. To tackle this challenge it is important that the different supply chain actors work together to find a solution since it is in all actors' interest to reduce the food waste.

### **5.1.5 Less packaging**

Regarding packaging, the results indicate there is a group of consumers with an increasing demand for less food packaging. The founders of the two package-free stores interviewed in this study are both environmentally conscious people that became frustrated with all the food packaging in today's society and then decided to open their own package-free stores. The appearance of package-free shops shows that people are becoming more environmentally conscious which also can be seen among the consumers interviewed in this thesis. For instance, Consumer 12 says she prefers to buy iceberg lettuce without packaging because she thinks plastic is bad for the environment and also food products in general are oftentimes over-packed. The food industry could face a packaging challenge if consumers start demanding less packaging and in some cases no packaging at all because today many food products are packaged.

Even though the demand for less packaging might increase, removing all primary packaging from food is presumably not the ideal solution because then the food wastage would probably grow. A challenge for the food industry is therefore, as mentioned by Wikström and Williams (2010), to evaluate each product in order to find the amount of packaging that minimizes the total environmental impact of both the packaging material and food wastage. Another challenge is then to make consumers understand that packaging is not always harmful for the environment and sometimes it is necessary if it reduces the total environmental impact.

## **5.2 Financial incentives' impact on food waste**

The food industry is a business and therefore different actors in the food supply chain ultimately strive to be profitable. However, this objective can sometimes clash with the effort to reduce the food wastage in the supply chain.

### **5.2.1 The economic benefit's impact on food waste reduction**

The results show that actors sometimes choose not to adopt possible food waste reduction methods because they are not financially profitable. For instance, one of the interviewed retailers mentions that they do not reduce the price on the products that are about to spoil since it would require extra work which would cost more than allowing the products to be wasted. The same phenomena is seen at the production stage. Iceberg lettuce producers sometimes choose to permit the lettuce to become waste instead of harvesting it if the market price for iceberg lettuce is lower than the costs related to harvesting. This finding supports what previous research has shown (Gunders, 2012). Prior research has also identified that some actors might perceive a low food waste level as something negative. For instance,



Gunders (2012) notes that retailers might view low food wastage as an indicator of a suffering customer experience due to low stock levels.

All businesses face financial tradeoffs and as a result, it is a challenge to overcome these economic incentives preventing supply chain actors from doing everything they can to reduce their food wastage. This could prove difficult since oftentimes the main objective of businesses is making profit. However, even though the waste reduction methods might not be directly financially beneficial for a business, they could potentially have positive indirect effects. For instance, iceberg lettuce producers want to harvest large heads of lettuce because they are paid according to their weight. Yet, consumers find it difficult to finish large heads of lettuce before they perish which leads to a higher wastage. If iceberg lettuce producers harvest smaller-sized heads of lettuce, it might add value to the consumers which could lead to them purchasing more iceberg lettuce rather than choosing another sort of lettuce.

### **5.2.2 Moving the food waste downstream in the supply chain**

As mentioned in the previous section, the main objective of most businesses is to be economically profitable which is accomplished by selling as much as possible. Selling products is not only beneficial from a financial point of view but also favorable from a food waste perspective at that particular actor since unsold food usually becomes waste. However, this is not always beneficial for all affected actor and selling more could move or even increase the wastage further downstream. If retailers have promotions then consumers might perform more spontaneous food shopping and also purchase more than they can consume, which ultimately contributes to higher amounts of food waste in households. This can occasionally also be true for reduced price on food products that are about to spoil. Consumers might be tempted to purchase the food only due to the cheaper price and then end up wasting the product because they did not have a real need for it. This does not reduce the total amount of food wasted, but only moves the wastage from the retailer to the consumer. However, since the food would probably become waste at the retailer if the consumers do not purchase it, this method of reducing the price on food products that are about to spoil, could be successful in reducing the overall food wastage in the supply chain. Hence, both food promotions as well as reduced prices of imperfect products might only lead to moving the current wastage further downstream. However, while promotions might increase the overall wastage, reduced prices of imperfect products has the potential to decrease the overall wastage.

This phenomena of tradeoffs between different objectives could also apply to other parts of the supply chain. It is therefore important to evaluate how other objectives affect the goal to reduce food waste. As discussed above, reducing the price on

food products has the potential of both reducing and increasing the overall food wastage depending on the circumstances of each case.

### **5.2.3 Connection between a product's price and its wastage**

As seen in the results, some consumers mention that they make more of an effort to reduce the wastage of products that are more expensive. This indicates that there might be a connection between prices and how much consumers waste. Undeniably, the money wastage is larger when throwing away expensive products, which might motivate consumers to waste less of these products. According to the results from the interviews conducted in this thesis, the food products consumers throw away the most are fruits, vegetables and bread. These are relatively cheap and common products and consumers might therefore not believe they lose that much money when wasting them, which might in turn lead to a greater wastage. However, since they are everyday products, the money loss of wasting small parts of a product, such as a few slices of bread, could quickly add up. One way of reducing the wastage of cheap daily products could thus be to make consumers aware of how much money they waste on throwing away the food over a longer period of time. The same concept might be applicable to other actors in the food supply chain.

### **5.2.4 Indirect financial gains from improved packaging**

Regarding packaging, it is a challenge for all actors to find a packaging solution that protects the iceberg lettuce well enough and that at the same time is economically beneficial. A good packaging solution can prevent the food from becoming damaged and eventually thrown away; but no actor wants to invest in such a solution if there is no profit in it for them. As seen in the results, regarding secondary packaging, the returnable plastic SRS containers seem to be preferred from a handling and environmental point of view by the producers, distributors and retailers interviewed in this study. However, they are more expensive which could mean that companies with smaller financial assets do not have the opportunity to freely select what packaging system to use. Therefore, the financial state of a company might affect how much food is being wasted.

According to the consumers interviewed in this study, there are consumers who would be willing to pay a slightly higher price for an improved iceberg lettuce primary packaging. Today, some consumers do not think the lettuce package is user-friendly and thus there is an opportunity to improve the packaging to contribute to a positive consumer experience. As a result, investing in improving the packaging might bring indirect financial gains through an increase in sales due to more satisfied customers.

Distributor 2 believes many actors choose to reduce the packaging budget when they need to cut costs because it is not considered very important. Yet, an improved secondary packaging solution could indirectly lead to a financial gain for the actors. For instance, if the secondary packaging does not protect the iceberg lettuce from freezing during transportation, there might be product damage and related administrative work regarding complaints. Both product waste and administrative work cost money and if a better packaging solution can protect the product and therefore avoid these costs, there is a potential financial gain. The indirect gains from packaging are not always obvious and they are usually hard to calculate. Nonetheless, it is crucial to make all supply chain actors understand how packaging can affect operations and potentially lead to financial gains not only close to them but also throughout the whole chain. To accomplish this it is crucial that the different actors communicate and work together (Verghese et al., 2013).

### 5.3 The challenge of maintaining a cold chain

McCurdy et al. (2009) point out that one of the reasons for food waste generation in the different stages of the supply chain is the failing to keep products in their optimal temperatures. This is especially true for perishable products, such as fruits and vegetables, which quality is highly affected by the temperature (Department of Agriculture and Food, 2016). In order to preserve a good product quality throughout the supply chain, it is thus important to maintain an appropriate cold chain which can prove extremely challenging.

Regarding iceberg lettuce, the results in this thesis indicate that the temperature the lettuce is kept in has a significant effect on its quality and therefore its wastage. This is supported by previous research (Öhgren et al., 2003; Cantwell & Suslow, 2002). Moreover, this thesis suggests that it is important to keep the temperature at a constant level in order to maintain a good product quality as long as possible. In reality, these requirements on the temperature is not followed throughout the supply chain. Even though it would be preferable, it is not realistic to believe a constant temperature of 0 °C, which Cantwell and Suslow (2002) state as the optimal temperature conditions, would be possible to maintain from the production to the consumption stage in the iceberg lettuce supply chain. For instance, it would be difficult for consumers to maintain an unbroken cold chain when bringing the lettuce home from the grocery store. Furthermore, the retailers would require many fridges with different temperatures in order to accommodate all products and their specific temperature requirements. Nevertheless, there might be room for improvement and packaging is one factor that could aid in upholding a cold chain, which will be discussed further in section 5.6.2. Maintaining a cold chain is a challenge that the whole supply chain faces and the challenge is likely applicable to most perishable food products, not only iceberg lettuce. All actors are involved

in this challenge and thus there is a significant need for collaboration and communication within the chain. The fact that food supply chains consist of several actors and each actor handles multiple perishable products at the same time, makes the challenge a difficult one.

## 5.4 The risk of food waste management

In order to reduce the negative effect that the food wastage has on the environment, it is important to handle waste in a satisfying manner. However, the results in this thesis indicate that a good waste management system might actually risk increasing the food wastage in the previous stage of the supply chain. If people know the waste is taken care of in a satisfying way, then they might not feel as guilty wasting food and in turn not attempt as hard to reduce their waste which causes the food wastage to increase. For instance, the bio trash bags might cause consumers to waste more food because the consumers know the food they throw in those bags will become biogas. Also, the results show that retailers are starting to donate food that is about to spoil to food rescue organizations and this could mean retailers feel wasting food is more acceptable because the food will go to people in need. Providing food for people in need is undeniably a good social deed, however, the fact that the food is being donated does not necessarily mean it is consumed and not wasted later in the supply chain. Hence, there is a risk that satisfactory waste management systems, by transferring the responsibility of the waste downstream in the supply chain, cause food waste to feel more acceptable and therefore contribute to an increase in the overall food wastage. Furthermore, Eriksson and Spångberg (2017) suggest in their report that different waste management systems have different effects on the environment, such as recycling fruit and vegetable waste is more environmentally friendly than using it for energy recovery. People might not be aware of this difference in waste management systems and therefore they might not select the optimal system which in turn leads to the wastage having an increased environmental impact.

## 5.5 Food waste in the supply chain

### 5.5.1 Actors blame each other for largest food waste contribution

The results indicate that the different supply chain actors blame each other for being the largest contributor to the overall food wastage. According to the results, consumers blame retailers and restaurants, while retailers blame consumers. Only a few interviewees claim the actor group they belong to waste the most of all

supply chain actors. Figure 1 in section 1.1.2 of this thesis, indicates that households tend to have the largest amounts of food waste and for fruits and vegetables, the production is also a significant contributor. The fact that many actors believe someone else in the supply chain is responsible for the largest wastage, might hinder the overall waste reduction process. If actors consider their own operations as not having any significant effect on the overall wastage in the supply chain, then they might not make any serious endeavors to reduce their wastage. Furthermore, the actors might deem the largest food waste contributor responsible for driving the waste reduction, however, if all actors blame each other then no one will lead the reduction process. Food waste quantifications can therefore, by enlightening the actors on the size of their wastage, act as a motivation to tackle the wastage problem. However, it is important that actors with smaller waste contributions do not settle and refrain from attempting to reduce their own as well as the overall food wastage. Even though they themselves do not have large amounts of waste, they might indirectly affect the wastage in other parts of the supply chain.

### **5.5.2 Collaboration and communication**

As seen in the previous sections of this chapter, collaboration and communication within supply chains are extremely important factors in reducing the overall amount of food waste. Taking iceberg lettuce as an example, producers overproduce in order to hedge against uncertainties such as fluctuations in demand. If the producers would collaborate with the retailers then they could potentially receive more accurate demand forecasts and thereby reduce the need for overproduction. This would in turn result in less iceberg lettuce waste.

Previous research has shown a need for improved collaboration between food supply chain actors (Matopoulos, Vlachopoulou, Manthou, &Manos, 2007). As mentioned in the theory, Verghese et al. (2013) suggest that collaborating on packaging can reduce food waste in the food supply chain. A need for better communication and collaboration related to food waste and packaging in each stage of the supply chain, is also seen in this study.

For instance, as observed in this thesis, it is important to communicate the significance of packaging's role in reducing food waste during transport, in order to ensure that suitable packaging is selected. Regarding iceberg lettuce, most actors believe the current packaging system is sufficient in preventing food wastage. Yet, one distributor firmly states that improved packaging could reduce the wastage significantly at the distribution stage of the supply chain. If the benefit of improved packaging would be communicated to the other actors, then they might be motivated to invest in better packaging. Also, retailers, as the interface between suppliers and customers, have an opportunity to communicate with consumers in order to reduce food waste. This can, for instance, be accomplished

by educating consumers about food waste and guiding them to purchase imperfect food. Concerning iceberg lettuce, informing consumers about the fact that the lettuce can still be edible on the inside even though the outer leaves look tired and encouraging them to not only purchase perfect-looking lettuce, might reduce the wastage.

The way different factors affect food waste throughout the supply chain might not always be obvious to all actors and in order to overcome this food waste reduction hinder, it is important that the supply chain actors collaborate and communicate with each other.

### **5.5.3 The impact of the supply chain length on food waste**

One of the interviewed producers believes shorter food supply chains have less waste than longer ones. Long supply chains consisting of many different actors mean more processes for the food to go through. The food quality can either be maintained or reduced in a process and the more processes a food product goes through, the higher the risk of a reduction in quality. For instance, if the supply chain only consists of a producer and consumer, the producer would be able to sell directly to the consumer. The risk of the product being wasted, e.g. due to product damaged, will be lower than if the product would have passed through a distributor and a retailer because processes, such as product handling, storage and transport, are eliminated. However, the fact that longer supply chains could have higher risks of food waste does not necessarily mean that a long supply chain has more waste than a short one. Ultimately, how much food waste a supply chain generates depends on, among other factors, how well each supply chain process maintains the product quality. The balance between supply and demand is another factor that affects the amount of food waste a supply chain causes. If the supply is higher than the demand, there will be more wastage.

### **5.5.4 The optimal packaging system from a food waste perspective**

As mentioned before, packaging can reduce food waste, however, the results show that there is not one ideal packaging system that always works for a specific food product. What the optimal packaging system looks like from a food waste perspective for a product depends on its specific supply chain. For example, iceberg lettuce requires different packaging systems depending on how it travels from farm to household. If a lettuce producer knows he will sell the lettuce the day after harvest straight to the end-consumer then a primary packaging is not needed because the lettuce does not have time to spoil. But if the supply chain is longer, a primary packaging is often needed to maintain the product quality throughout the whole supply chain and thus preventing food wastage. However, there might not exist a packaging system that is optimal with regards to food waste for all supply

chain actors at the same time, due to the actors having different packaging requirements. It is therefore a challenge to find a packaging system that reduces the overall supply chain food wastage. Furthermore, when designing the packaging system, each case needs to be evaluated individually because there is not one optimal system that works for all supply chains.

## 5.6 Packaging opportunities for iceberg lettuce

In this section, potential packaging opportunities related to reducing iceberg lettuce waste will be discussed based on the combination of the theory, the result and the above discussion of different challenges regarding food waste and packaging. Improving the packaging will likely increase the packaging cost which will always be a tradeoff that needs to be taken into consideration when designing the packaging. This tradeoff has been discussed in section 5.2.4 and will therefore not be further discussed in this part of the chapter.

### 5.6.1 Protection

As stated in the theory, packaging can reduce product waste by protecting the product from its external environment as well as from physical damage (Molina-Besch&Påsson, 2016). The results indicate that the supply chain actors believe the primary packaging for iceberg lettuce protects the lettuce well enough from its surrounding environment; it protects the lettuce from consumers' touch in grocery stores and it prevents diseases from spreading between different heads of lettuce during transport. Furthermore, the results show that the secondary packaging is important in preventing physical damage in transport and handling operations. In this case, returnable plastic containers offer better protection from physical damage than cardboard boxes. However, the returnable plastic containers might be difficult to use between different countries. For instance, the process of transferring the containers might be more complicated and expensive. Additional packaging material, such as a packaging layer covering the opening of open cardboard boxes, can also contribute to less product damage and thus less waste.

### 5.6.2 Temperature and ventilation control

According to McCurdy et al. (2009), the quality of food is mainly affected by the temperature and humidity it is kept in. Also, cold temperatures are preferable for iceberg lettuce in order to reduce the respiration as well ethylene release rates (Silva, 2010; Danish Technological Institute, 2008). Better temperature control could thus help maintain a good iceberg lettuce quality throughout the supply

chain and therefore reduce the wastage. For instance, from the data collected in this thesis, it has been seen that iceberg lettuce quality is affected during transport due to the difficulty of maintaining a stable temperature. Using returnable plastic containers instead of cardboard boxes could reduce the wastage because the returnable plastic containers do not need to be placed on top of the other products. This means that the products are not as exposed to temperature fluctuations as they would be in cardboard boxes.

Furthermore, the results of this study indicate that corrugated board can help maintain some warmth in the iceberg lettuce without overheating them. If open cardboard boxes are used as secondary packaging, then covering the opening with packaging material can help protect the lettuce from temperature differences. Thus, an improved packaging could better protect the iceberg lettuce from becoming too warm or too cold. Additionally, according to the results, it is important that the packaging material contains holes to allow air to circulate and to prevent condensation.

### **5.6.3 Extending shelf life**

Mena (2011) has shown that packaging can extend the shelf life of food products. The majority of the consumers interviewed in this study say that they throw away iceberg lettuce because it becomes inedible. It is important to understand why consumers claim they do not have time to finish the lettuce before it is considered inedible. If the reason is their behaviors, such as buying too much or forgetting food in the fridge, then focus should maybe be on educating consumers and making them change their behaviors instead of on extending the shelf life of the product. But extending the shelf life can provide consumers with longer time to finish the food before it expires which reduces the food wastage if the reason for wasting is not being able to consume the whole product before it spoils.

As seen in section 3.2, there are several methods of extending shelf life through packaging, especially primary packaging, such as different packaging materials and technologies. Regarding iceberg lettuce, packaging solutions that reduce the respiration rate as well as the amount of ethylene that is reduced, might be beneficial since these are factors affecting the quality of iceberg lettuce.

When selecting which extending shelf life method to use, there are many factors to take into consideration and each case must be evaluated individually. For instance, will the new packaging design affect the price of the product? If so, are the consumers willing to pay more for the improved packaging? The results in this study indicate that most consumers are not willing to pay more for better iceberg lettuce packaging. If this is the case then it would probably not be profitable to improve the packaging. However, it is important to know why the consumers are not willing to pay more. For instance, it might be because they do not realize the advantage an improved packaging could have on the shelf life and then it is



important to educate consumers on the topic. Hence, it is crucial to evaluate each situation carefully before undertaking a new packaging design with the aim of extending a product's shelf life.

#### **5.6.4 Information**

As mentioned in theory, Molina-Besch and Pålsson (2016) say that the different packaging levels need to contain appropriate information in order to avoid damage and waste of the product throughout the supply chain. In the case of iceberg lettuce, it would be possible to add useful information, such as preferred storage temperature, on the packaging in order to inform the different actors in the supply chain on how to handle and store the lettuce in order to reduce its wastage.

What is more, the result shows that there is a need to inform the consumers about the role packaging has in reducing food waste. There is thus an opportunity to, through packaging, inform consumers about the primary packaging's role in maintaining a good iceberg lettuce quality. The primary packaging is adapted to the lettuce, e.g. it is perforated to allow the lettuce to breathe, in order to maintain a good product quality as long as possible. Most consumers put the iceberg lettuce in a new plastic bag which is not specifically meant for lettuce or vegetables in general. The absolute majority of consumers interviewed in the study say they feel comfortable they store the lettuce in the best possible way which they have learnt from past experience and from seeing how others store their iceberg lettuce. The consumers do not seem aware of the fact that the primary packaging is adapted to the lettuce, in fact some consumers remove the original plastic bag because they believe it contributes to making the lettuce spoil faster than it would if it were stored in another way. This phenomena has also been found in previous research (Plumb, Downing & Parry, 2013). However, the producers interviewed in this thesis note that whether or not iceberg lettuce is stored in its original packaging in the households is not of great importance because it is just a matter of a short period of time, such as a few days. Thus, changing the primary packaging at home does not have a significant effect on the quality of the lettuce, but it is a waste of resources using another bag. Moreover, there might be cases with other products where the product is more sensitive to how it is stored and would spoil quicker if not kept in its original packaging. Therefore, it is important to educate consumers about packaging's role in maintaining a good product quality in order to ensure the consumers understand the significance of storing the product in its original packaging. This education could be done through the packaging.

#### **5.6.5 User friendliness**

As mentioned in the results, a large part of the interviewed consumers remove the primary packaging from the iceberg lettuce in the households because it is difficult

to reclose or it breaks when opening it. Molina-Besch and Pålsson (2016) suggest that the packaging need to be easy to use for the consumer to reduce its product waste. There is thus an opportunity to improve the opening part of the primary packaging for iceberg lettuce so that it can be reclosed more easily and does not break when opening. If the primary packaging is more user friendly then consumers might not remove it which could affect the lettuce quality and reduce the wastage.

In addition, concerning the cardboard box as the secondary packaging, it is possible to have shelf ready packaging which would reduce double handling when replenishing the retail stores and decrease the risk of damage (Verghese et al., 2013). Also, the secondary packaging contains useful information such as origin, weight and brand that consumers might be interested in knowing. The shelf ready concept would probably not work for the returnable plastic container, so when deciding the secondary packaging, it is important to consider all the tradeoffs between cardboard box and returnable plastic container.

# 6 Conclusions

*In this chapter, the three research questions are answered and then the main conclusions of this thesis are summarized.*

## 6.1 Answering the research questions

- What challenges and opportunities are there for the actors in the supply chain, i.e. from farm to household, concerning food waste, especially iceberg lettuce waste?

Challenges:

- Lacking motivation, knowledge and awareness among consumers related to food waste.
- Dealing with high consumer requirements.
- Overcoming financial incentives not to reduce food waste.
- Maintaining a cold chain throughout the supply chain.
- Dealing with the fact that having good food waste management systems might lead to wasting food being more acceptable.
- Reducing the overall supply chain wastage.

Opportunities:

- Motivate, educate and create awareness among consumers about food waste and consumers' impact on it.
- Create awareness of how food waste reduction methods can provide indirect benefits for the supply chain actors.
- Improve packaging in order to reduce food waste in the supply chain.
- Collaborate and communicate among the different supply chain actors in order to reduce the overall food wastage.

- What challenges does the packaging system have related to food waste, especially iceberg lettuce waste, in the supply chain?
  - Handling demands for less packaging.
  - Dealing with the fact that actors might not be willing to invest in packaging.
  - Managing consumers' lack of awareness of packaging's role in reducing food waste.
  - Finding an optimal packaging system from a food waste perspective.
- How can packaging designs potentially reduce iceberg lettuce waste in the supply chain?
  - Protect
  - Control temperature and ventilation
  - Extend shelf life
  - Inform
  - Increase user-friendliness

## 6.2 Main conclusions

The main conclusions of this study are the following:

- There is a need to view the whole supply chain when trying to reduce food waste.
- Packaging can reduce food waste in the supply chain.
- There are many factors, such as a lack of motivation as well as knowledge, conflicting interests as well as financial incentives that hinder the ability to reduce food waste in the supply chain.

## 7 Future research

*Below, future research is suggested based on this study.*

- The approach used in this study can be applied to other supply chains to evaluate actors' behaviors and opinions related to food waste and packaging as well as packaging's role in reducing food waste.
- Based on the potential packaging opportunities, different packaging materials and technologies need to be evaluated in order to determine their potential effect on the wastage of iceberg lettuce.
- Further investigation related to how satisfactory waste management systems might impact the food waste negatively.
- Quantify the iceberg lettuce waste in households.

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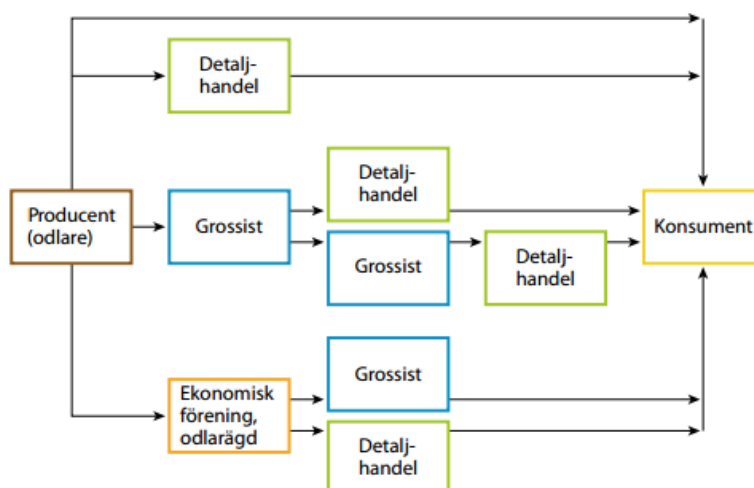
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# Appendix A: The supply chain of iceberg lettuce

The supplychain for iceberglettuce from the article “Svinn av isbergssallat i primärproduktionen och grossistledet i Sverige” (Strid et al., 2014).

Figur 1. Distributionskedjan för isbergssallat i Sverige till detaljhandeln och konsument.



# Appendix B: Interview questions

## B.1 Interview questions for consumers

Food waste:

1. Do you waste food? Why?
2. What do you think about the food waste?
3. When do you think about food waste in your daily life?
4. Do you see a problem with food waste?
5. Do you take any actions to reduce food waste?
6. Who in the supply chain do you think wastes the most food? Why?

Iceberg lettuce:

1. How do you select which lettuce to buy?
2. How do you store the lettuce at home?
3. Do you use all of the lettuce at once?
4. Do you throw away any lettuce?
5. What could make you throw away less iceberg lettuce?
6. If only part of the lettuce looks bad, do you throw away the whole package?

The packaging:

1. What do you think about packaging in general?
2. What do you like and don't like about the packaging for iceberg lettuce?
3. What information on the iceberg lettuce package is important to know for you?
4. Are you willing to pay more for better packaging quality for iceberg lettuce?

## B.2 Interview questions for retailers and package-free stores

Retailers:

Food waste:

1. What do you, as a retailer, think about food waste generally in the food industry?
2. How do you view food waste at your store?
3. How do you deal with the waste?
4. Who in the supply chain do you think wastes the most food? Why? Producer? Distributor? Retail stores? Restaurants? Households?

Iceberg lettuce:

1. How often do you get deliveries?
2. How do you handle iceberg lettuce?
3. Do you think the wastage of iceberg lettuce is a problem for your store?
4. How do the operations affect the quality of the lettuce?

The packaging:

1. What do you think about packaging in general?
2. What do you think about the packaging system of iceberg lettuce?
3. What requirements do you have on the packaging for lettuce?
4. Does the packaging affect the quality and wastage of iceberg lettuce?

Packaging-free stores:

1. How does the concept work?
2. What products do you have?
3. Why did you start this store? View of packaging?
4. What do you think of food waste in general?
5. Does the packaging affect the quality of the product?

## B.3 Interview questions for distributors

Iceberg lettuce:

1. How do the different processes from receiving to shipping the iceberg lettuce work?
2. How do the operations affect the quality of the lettuce?
3. Is there any wastage of lettuce in the operations performed? How do you deal with it?
4. How long does the lettuce stay on average in the distribution center?
5. How is the iceberg lettuce transported to and from the distribution center?

6. Does the size of the lettuce matter?

Food waste:

1. Who in the supply chain do you think wastes the most food? Why?
2. Do you have any comments or suggestions on how to reduce food waste during transportation?

The packaging:

1. What does the packaging system for iceberg lettuce look like?
2. Does the packaging affect the quality and wastage of iceberg lettuce?
3. What do you think about the current packaging system for iceberg lettuce? Is it optimal? Any comments?
4. What problems does the packaging system have on the food waste in the supply chain, especially on iceberg lettuce?

## B.4 Interview questions for producers

Iceberg lettuce:

1. How does the harvesting/packaging/storing of iceberg lettuce work?
2. What factors during the production operations can affect the quality of iceberg lettuce?
3. Can you control the size of the iceberg lettuce heads?
4. Is there any waste in the production of lettuce? Why?

Food waste:

1. Who in the supply chain do you think wastes the most food? Why?

The packaging:

1. What does the packaging system for iceberg lettuce look like?
2. Who decides which packaging should be used?
3. Why do you have packaging on iceberg lettuce? Any comments?