The Packaging's Role in Prevention of Product Waste

- The Supply Chain of Bread

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MASTER´S THESIS

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The Packaging's Role in Prevention of Product Waste

The Supply Chain of Bread

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SWEDEN

ISRN: 13/5113

Printed by Media Tryck

Lund 2013

Preface

This master thesis was performed as the last assignment of the education to Civil Engineer in Biotechnology. The project has been conducted at the Division of Packaging Logistics, Faculty of Engineering, Lund University.

I like to thank my supervisor at the Packaging Logistics division, Katrin Molina-Besch, for her continuous support, positive attitude and valuable ideas during the progress of this thesis.

Work was performed in cooperation with actors at different levels in the supply chain of bread. Thanks are also given to them for sharing information and insight in their work, making this thesis possible.

June 2013

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Abstract

Purpose of Thesis

Food lost or wasted constitutes a substantial environmental, economic and social problem; today roughly one-third of edible parts of food that is produced for human consumption globally gets lost or wasted. Thus, a reduction of waste would contribute to a sustainable use of resources. It has been highlighted that packaging development has the potential to play an important role in this process. Further, bread appears to be an interesting product to investigate since it gets lost or wasted in a large quantity in developed countries and since it is a food product that is sold both packed and unpacked. This thesis examines the formation of waste along the supply chain of bread and tries to sort out aspects that can be connected to the packaging of the product. Further it investigates if there are possibilities to optimize bread-packaging systems in order to decrease the amount of wasted bread.

Design/Methodology

To examine the connection between bread waste and the packaging an inductive method was used, trying to draw general and theoretical conclusions based on empirical data. To begin with, a literature review was conducted. The theory was then further used to perform interviews with three different supply chain actors: producers, retailers and consumers. Packaging experts at industrial bakeries and managers at retail stores were addressed with semi-structured interviews face-to-face while consumers were targeted with structured interviews in the form of oral questionnaires.

Findings

This thesis concludes that there are aspects in relation to the packaging with the possibility to affect the amount of wasted bread. Primarily the connection to packaging size and date labeling system is discussed. In addition to this, results suggest additional aspects - without relation to the packaging - that have extensive impact on the formation of bread waste. Suggested measures for improvement concern mainly the behavior of consumers and waste formation in households and retail stores.

Research Limitations

Interviews were performed with three producers and three retailers in the southern part of Sweden. A total of 50 consumers were targeted with questionnaires in five different retail stores. A larger number of participants, in both interviews and questionnaires, might help strengthening the significance of results.

Future

Results from this thesis can be used to optimize the design of bread packaging systems, in an attempt to reduce the amount of wasted bread. A consumer survey of the interpretation and importance of different date labels and an investigation of main reasons for different bread producers to have varying return rates seem like important topics for future improvements.

Sammanfattning

Introduktion

Matsvinn är ett aktuellt ämne som har fått mycket utrymme i medierna den senaste tiden. I dag slängs eller förstörs ungefär en tredjedel av alla ätliga delar av livsmedel som produceras för mänsklig konsumtion världen över (FAO, 2011). Mat som förstörs eller kastas längs med försörjningskedjan, från producent till konsument, utgör en stor belastning på miljön. Därför skulle en minskning av svinnet kunna bidra till ett hållbart resursutnyttjande (FAO, 2011; FAO *m.fl.,* 2012; Williams *m.fl.,* 2012; Norden, 2012; Naturvårdsverket, 2008). I utvecklade länder kastas stora mängder mat och mer än 40 % av förlusterna sker i butik eller konsumentleden. I utvecklingsländer däremot förloras mer än 40 % av livsmedel under arbetet efter skörd och bearbetning, och svinnet i konsumentledet är minimalt (FAO, 2011). Svinnet är dessutom en ekonomisk och social fråga eftersom en stor del av världens befolkning lider av kronisk undernäring (FAO *m.fl.,* 2012). Vissa åtgärder har redan genomförts för att lösa detta omfattande problem - men det krävs mer. Utveckling av förpackningssystem har påpekats som en viktig del i detta arbete (Parfitt *m.fl.,* 2010; Williams och Wikström, 2011; Norden, 2012; Naturvårdsverket, 2008). Det är ännu oklart hur stor påverkan förpackningen kan ha direkt på mängden mat som slängs och vad som blir mer ett resultat av förändrade konsumentbeteenden till följd av anpassade förpackningar (Williams och Wikström, 2011).

Problemformulering och syfte

Rapporter och publikationer från myndigheter och andra organisationer visar att matsvinn är ett allvarligt problem som behöver åtgärdas. Förpackningen spås ha en möjlighet att vara en del i arbetet med att minska svinnet. I utvecklade länder tycks störst möjlighet att minska svinnet finnas i butiks- och konsumentleden. Samtidigt verkar det också viktigt att utreda varför svinn bildas, i relation till förpackningar, i tidigare steg av försörjningskedjan. Än så länge har dock få studier gjorts på hur förpackningsdesignen påverkar mängden svinn. Genom att undersöka var, när och varför mat kastas i en försörjningskedja skulle det vara möjligt att identifiera faktorer som kan kopplas till förpackningen av produkten. I detta projekt kommer fokus ligga på att undersöka svinnet i en försörjningskedja av bröd. Syftet är att hitta svar på om förpackningen skulle kunna optimeras för att minska svinnet av bröd samt vilka förpackningsaspekter som i så fall kan komma att ha betydelse. Den tänkbara kopplingen mellan brödsvinn och förpackningsaspekter kommer att utredas i produktion, butik och konsumtionsleden.

Teori

Brödsvinn

Bröd har en ganska liten miljöpåverkan, jämfört med många andra livsmedel som till exempel ost och kött (Modin, 2011). Å andra sidan har det rapporterats i många länder att stora mängder bröd kastas, speciellt i konsumentledet (Karlsvärd *m.fl.,* 2008; Fredriksen *m.fl.,* 2010; Ventour, 2008; WRAP, 2009; Modin, 2011). Den stora mängden brödsvinn gör att försörjningskedjan av bröd är intressant att undersöka.

Brödsvinn kan uppstå i industriella bagerier på grund av saker som viktvariationer, oregelbunden form samt då bröd och deg faller av transportband. Vidare produceras bröd mot en order och för att säkerställa leverans produceras ett visst antal fler bröd för att kompensera för oförutsägbara förluster under produktionen. Detta skapar också ett visst svinn, ”överbak”, då produktionssvinnet inte uppgår till den beräknade mängden (Karlsvärd *m.fl.,* 2008).

Butiker måste överkomma problemen med att erbjuda sina kunder välfyllda brödhyllor genom att sälja så mycket av brödet som möjligt för att hålla nere returer. Svårigheterna med att beställa rätt mängd har pekats ut som en av de största orsakerna till att brödsvinn bildas i butiker (Karlsvärd *m.fl.,* 2008). Vissa produkter, däribland bröd, kan returneras från butiker till producenter utan extra kostnad för butiken. Detta fråntar butikerna ekonomiskt ansvar för svinnet som bildas till följd av returer och på så vis är det möjligt att noggrannheten i beställningarna påverkas (Norden, 2011).

Flera studier har visat att konsumenter står för en stor del av brödsvinnet i samhället. En analys av avfallet från norska hushåll visade att 27 % av soporna bestod av bröd och bageriprodukter (Fredriksen *m.fl.,* 2010). Analysen kunde också avslöja att mer än 50 % av brödet hittades i sin originalförpackning. I en studie gjord av Konsumentföreningen Stockholm svarade 41 % att de hade kastat bröd under den senaste veckan (Consumer Association of Stockholm, 2009). WRAP, The Waste and Resources Action Programme, har genomfört undersökningar och fastslår att bröd är det livsmedel som slängs i näst störst mängd i Storbritannien, efter potatis. Studien visade att så mycket som 29 % av allt standardbröd som köps i Storbritannien kastas (WRAP, 2009). De vanligaste anledningarna som uppgavs av konsumenter till varför de kastar bröd var att det hade passerat sitt datum, såg dåligt ut eller hade möglat (Ventour, 2008).

Brödförpackningar och svinn

Generellt sett har många olika förpackningsaspekter kopplats till mängden mat som blir svinn (Williams *m.fl.,* 2008; Williams *m.fl.,* 2012 och Parfitt *m.fl.,* 2010). När det kommer till just bröd är informationen knapp angående vilka förpackningsaspekter som kan kopplas till svinnet. Den stora mängden bröd i hushållsavfall kan hur som helst tyda på att det finns ett behov av mindre förpackningar (Karlsvärd *m.fl.,* 2008). Dessutom har datummärkningen av bröd visat sig påverka konsumenters beteende. I en internetundersökning gjord av Konsumentföreningen Stockholm undersöktes konsumenters attityd till datummärkning och matsvinn (Consumer Association of Stockholm, 2009). En tredjedel av de svarande höll helt med om att en orsak till att de kastar mat ofta är att den har passerat sitt bäst-före datum. Vidare så visade samma studie att 62 % av alla medverkande skulle föredra om mat märktes med ”minst hållbar till” istället för bäst före. En sådan märkning skulle bättre visa att maten fortfarande kan vara tillräckligt bra för att konsumeras även om bäst-före datumet har passerats (Consumer Association of Stockholm, 2009). Alltså skulle kanske en förändring av det befintliga datumsystemet kunna minska mängden bröd som konsumenter kastar och/alternativt den mängd som tas i retur i butikerna.

Avfallshantering

Fredriksen *m.fl.* (2010) konstaterar att det är tio gånger mer effektivt att förhindra bildandet av svinn än att hantera svinnet med den mest miljövänliga och

resurseffektiva metoden som finns. Det är i linje med den hierarki som appliceras i EU-länder. Där är motverkan av bildandet av sopor högsta prioritet (Avfall Sverige, 2012; European Council, 1994). I dag har ungefär 60 % av svenska kommuner infört separat hantering av organiskt avfall (Avfall Sverige, 2012). Mjukplast, som till exempel tomma brödpåsar, ska sorteras i samma container som hårdplast sedan den 1:a november 2008 (VA SYD, 2012 a). Ingen information angående dagens omfattning rörande sopsortering av bröd och brödförpackningar kunde hittas i litteraturen.

Metod

För att undersöka sambandet mellan brödsvinn och förpackningsaspekter användes en induktiv metod. En sådan kan användas för att försöka dra generella och teoretiska slutsatser från empiriska data (Wallén, 1996 p. 47; Holme and Solvang, 1997 p. 57). Som ett inledande steg gjordes en litteraturgranskning för att sammanställa befintliga teorier och skapa en bild av tidigare studier i ämnet. Denna teori kunde sedan användas för att utforma lämpliga frågor till intervjuer och enkäter.

En del av det utforskande arbetet utgjordes av intervjuer med tre förpackningsansvariga på olika brödproducerande företag i södra Sverige samt tre butiksanställda, ansvariga över brödavdelningen, på olika butiker i Malmö. En kvalitativ metod användes för att få en bred, beskrivande bild av situationen i de här två stegen av försörjningskedjan. Intervjuobjekten valdes ut med omsorg för att få största möjliga kunskap om bröd, förpackningar och svinn i de olika stegen. Butiker med olika prisstandard inkluderades i studien. Expertintervjuerna spelades in och transkriberades ord för ord, sedan markerades nyckelord samt fraser som ansågs relevanta för det undersökta ämnet.

Det sista steget i försörjningskedjan – konsumenterna – undersöktes med en mer strikt, kvantitativ metod. Istället för intervjuer genomfördes här enkäter med förutbestämda svarsalternativ eftersom det ansågs ge ett resultat på ganska kort tid. Målet med enkäterna var att ta reda på hur mycket bröd konsumenter kastar, varför de kastar bröd samt deras relation till brödförpackningar. Informationen som samlades in med hjälp av enkäterna kunde i vissa fall jämföras med resultat från tidigare studier. Enkäten fylldes i av intervjuaren under mötet med konsumenten. Sammanlagt svarade 50 konsumenter på enkäten. För att inkludera så många olika typer av konsumenter som möjligt genomfördes enkäten i fem olika butiker belägna i olika delar av Malmö samt på olika dagar och vid olika tid på dagen. Både män och kvinnor i en varierande ålder medverkade.

Resultat och diskussion

Producenter

Intervjuer visade att brödförpackningen i sig kan orsaka svinn i produktionen men packat bröd slängs ändå inte i större utsträckning än lösviktsbröd i detta steg. Ofta bildas relativt lite svinn i produktionen jämfört med de efterföljande stegen. Därför finns också mest att vinna på att göra förändringar som minskar svinnet i butiker och konsumentledet, speciellt eftersom slösandet av resurser ökar ju längre fram i

kedjan ett livsmedel kommer innan det slängs. Producenter har möjlighet att påverka svinnet i senare steg bland annat genom att erbjuda lämpliga förpackningslösningar och samarbeta med butiker när det kommer till att lägga beställningar. Intervjuerna visade också att de producenter som har tillgång till information från butikernas kassasystem när de planerar beställningar har mycket lägre returer än de som inte har den möjligheten. Vidare är det också vanligt att det finns ett avtal om full returrätt mellan producenter och butiker. Det verkar svårt att konkurrera på marknaden om ett sådant avtal inte erbjuds. Som en följd av kontraktet med full returrätt är det ofta försäljare på det producerande företaget som beställer mängden bröd som ska levereras till respektive butik. Det är svårt för alla parter att förutse kommande försäljning, men det verkar som att ett bättre samarbete mellan butik och producent skulle kunna förbättra denna process.

Förpackningsansvariga visste inte vad konsumenter anger som främsta anledning när de kastar bröd. En bättre dialog mellan de två parterna skulle kunna resultera i förbättringar av förpackningarna på ett sätt som önskas av konsumenter. Det verkar möjligt att mindre förpackningar skulle kunna minska mängden svinn. Dessutom skulle dagens datummärkningssystem behöva utvärderas. Detta eftersom framförallt information om bakdag påverkar konsumenters beteende enligt förpackningsansvariga. Vidare kanske inte bäst före-datumet tolkas på rätt sätt av konsumenter i dag. Slutligen kan det konstateras att konsumenter styr marknaden och den vinstdrivna attityden går inte alltid hand i hand med viljan att minska mängden svinn.

Butiker

I butiker bildas en stor del av det bröd som slängs i form av osålda varor som måste sändas i retur till producenterna. Ett resultat av avtalet med full returrätt är att butikerna inte har något ekonomiskt ansvar för returerna förrän de överstiger en viss andel av den totala försäljningen. Butikerna är nöjda med avtalet med full returrätt. För att producenterna ska kunna minska sitt svinn föreslår butikerna att sortimentet ska minskas samt att beställningarna ska utföras med mer precision och hänsyn till de rådande omständigheterna. I dag händer det att butikerna assisterar i arbetet med att lägga beställningar. Som en följd av returavtalet verkar det dock som att butikerna inte har någon större motivation till ett intensivare samarbete eftersom det är miljön och producenterna som skulle vinna mest på mindre returer – inte butikerna själva. Det verkar som att ett bättre samarbete med beställningen av bröd skulle kunna bidra till att minska svinnet.

Vanligtvis finns ingen direkt koppling mellan förpackningen och det svinn som bildas i butiker. De butiksanställda hade inte lika stort intresse av eller samma mängd tankar kring brödförpackningar som producenter och konsumenter. Hanteringen av bröd i butiker påverkar dock mängden svinn. Intervjuer avslöjade vidare att producenter kompenserar för finansiella förluster till följd av svinn med att sätta ett högre pris på sina produkter. Alltså betalar konsumenter som köper bröd också för det bröd som slängs. Även om det inte finns någon direkt koppling mellan svinn och förpackningen i butiker har förpackningen i alla fall en stor inverkan på konsumenters beteende. På så sätt påverkar den indirekt den mängd svinn som bildas i butiker. Butiksanställda med brödansvar trodde hur som helst inte att förändrade förpackningsstorlekar kan minska mängden svinn och bara en av

tre trodde att ett annat datummärkningssystem skulle hjälpa. Sammanfattningsvis relaterade inte butiksanställda brödsvinnet till förpackningen utan mer till problemet med att lägga beställningar av lämplig storlek.

Konsumenter

Från de 50 enkäter som genomfördes kan det konstateras att konsumenter kastar en betydande mängd bröd. Konsumenter uppgav att de köper nästan dubbelt så mycket packat bröd som lösviktsbröd och det är också det packade som slängs i lite större utsträckning. Konsumenter yngre än 25 och äldre än 70 år slänger minst bröd. Män slänger lite mer än kvinnor och de som kastar mest är ofta i åldern 41-55 år. Vidare är det svårt att avgöra hur hushållsstorleken påverkar mängden bröd som kastas. Ibland slänger stora hushåll mer än de med bara en person, det är möjligt att det helt enkelt beror på att det är lättare att planera sin konsumtion om man bor ensam.

Studien visar att svenska konsumenter inte är lika känsliga för datummärkningarna som brittiska konsumenter varit i tidigare studier. Det kan ändå konstateras att vissa människor fattar sina beslut om konsumtion baserat på datum. Den vanligaste orsaken till att bröd slängs är för att ”det såg dåligt ut” – vilket inte har med datummärkningen att göra. Tydligt är dock att konsumenter vill tillskriva anledningen till att de kastar bröd för stora förpackningar. Frågan är om konsumenter skulle köpa mindre förpackningar om dessa fanns eftersom de oftast är dyrare per kg bröd.

En stor andel brödkonsumenter återvinner aldrig eller sällan brödförpackningen. Kanske kan det pågående införandet av sopsortering hjälpa till att öka återvinningen även av förpackningar. Då brödet avlägsnas från påsen och sorteras som organiskt avfall kanske fler inser att det finns en speciell plats i sorteringssystemet också för förpackningen.

Slutsatser

- Den generella attityden är att brödsvinn inte är ett problem.
- Brödförpackningen varken orsakar mer eller minskar mängden svinn i produktionen (jämfört med lösviktsbröd).
- En större andel svinn bildas i butik- och konsumentleden än produktionen.
- Det finns förpackningsaspekter som troligtvis kan kopplas till svinnet av bröd: förpackningsstorlek samt datummärkningssystem (bakdagsinformation och bäst före).
- Det finns aspekter som inte är relaterade till förpackningen som kan kopplas till brödsvinn: returavtal, tillgång till information från kassasystem samt orderrutiner.
- En minskning av brödsvinnet kan kräva ett övergripande samarbete längs hela försörjningskedjan för att ge resultat.

Slutligen kan konstateras att det är önskvärt att resultat från denna studie används ihop med resultat från tidigare undersökningar för att optimera brödförpackningar och minska mängden bröd som går till spillo.

List of Abbreviations

EC – European Council

EEA – European Environment Agency

EU – European Union

FAO - Food and Agriculture Organization of the United Nations

FSC – Food Supply Chain

MAP – Modified Atmosphere Packaging

PE – Polyethylene

PET – Polyethylene terephthalate

PP – Polypropylene

SIK – The Swedish Institute for Food and Biotechnology

UK – United Kingdom of Great Britain

WRAP – Waste and Resources Action Programme

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1. Introduction

1.1 Background

Food waste is a subject in question that has gained public interest lately. Food lost or wasted in the food supply chain constitutes a substantial environmental strain and thus, a reduction of waste would contribute to a sustainable use of resources (FAO, 2011; FAO *et al.,* 2012; Williams *et al.*, 2012; Norden, 2012; Naturvårdsverket, 2008). Several actions have been taken to solve this extensive problem but more is needed to get sufficient results. It has been highlighted that packaging development has the potential to play an important role in this process (Parfitt *et al.*, 2010; Williams and Wikström, 2011; Norden, 2012; Naturvårdsverket, 2008).

1.1.1 Food Waste Definition and Quantification

Food losses are formed along several steps in the food supply chain. Losses in early steps of the chain like production, post-harvest and processing are often referred to as food losses (Parfitt *et al.*, 2010). Mistakes in production like weight variation, wrong baking settings or products falling from conveyor belts can cause substantial losses in the bread-producing industry (Svenberg and Torgå, 2007). Post-harvest losses in developed countries can many times be associated with the rigorous quality standards on shape, size weight and appearance of crops that are applied – for example, all carrots should be straight and bright orange, otherwise they are out-graded (Stuart, 2009). Post-harvest losses in developing countries can be the result of poor storage facilities and lack of infrastructure. Another example of formation of food losses is when potatoes are cut into strips during French fries processing and unwanted pieces of potatoes are sorted out (FAO, 2011). Losses at later stages of retail and consumption are rather referred to as food waste. In the end food losses and waste lead to a reduced amount of food mass that was initially intended for human consumption (Parfitt *et al.*, 2010). Some of the wasted food can be regarded as avoidable, food that could have been consumed if managed differently, and some as unavoidable, for instance bones and peels that humans are not likely to consume (Norden, 2012).

In Europe 20-30 % of the total environmental impact from consumption is related to food production (Tukker and Jansen, 2006). End consumers waste a large quantity of food and some is lost due to damaged or destroyed products along the production and distribution chain. The issue of food losses is of high importance for several reasons. Waste and loss of food that requires an extensive amount of resources like land, water and energy to produce has a large, and many times unnecessary, impact on the environment (Williams *et al.*, 2012). A destroyed product further means economic loss for the producer or consumer. Additionally, there is an ethical aspect of wasting food since a large part of the world's population is living their life in constant hunger. 870 million people have been reported to suffer from chronically undernourishment in 2010-12 (FAO *et al.*, 2012).

The extent to which food is lost and wasted seems to be difficult to estimate, and varying numbers have been reported. The Food and Agriculture Organization of the United Nations (FAO) reports that roughly one-third of edible parts of food that is

produced for human consumption globally gets lost or wasted (FAO, 2011). Although there are a lot of different estimates of the scope of the problem, it can be concluded that there is a great potential in reducing the amount of food losses and waste. In this way the environmental impact from the food industry could be reduced.

1.1.2 Food Waste Origin

There is a variation at what stage in the food supply chain that the main food losses occur in different parts of the world. In developed countries the majority of the food is wasted, i.e. thrown away, and more than 40 % of losses occur at retail and consumer levels. Often the production level even exceeds the demand (FAO, 2011). One thing confirming that there is a huge amount of food available in developed countries is that although big losses occur sometimes, e.g. due to recalls to ensure food safety, this doesn't render in a shortage in the society (Lundqvist *et al.*, 2008). In developing countries however, more than 40 % of produced food is lost at post-harvesting and processing, and waste at the consumer phase is minimal (FAO, 2011).

1.1.3 Role of Packaging in Prevention of Food Waste

It has been concluded that the greatest potential for reduction of food waste in the developed world lies at the retail and consumer levels (Parfitt *et al.*, 2010; FAO, 2011). Through education the consumers' knowledge of the relation between food waste and environmental impact can be increased (Parfitt *et al.*, 2010; FAO, 2011; Norden, 2011). Other factors might require governmental interventions or regulations or a change from the food industry itself (FAO, 2011; Norden, 2011). The literature shows that a change throughout the food chain from the producer to the consumer has the potential to substantially reduce the environmental impact from food waste (Parfitt *et al.*, 2010; FAO, 2011; Norden, 2011; Naturvårdsverket, 2008). From this standpoint the importance of considering the effect of food packaging systems in total and not only the packaging or the food has been highlighted. It has been reported in several studies that packaging has an important role in the prevention of food waste (Norden, 2011; Williams *et al.*, 2012; Naturvårdsverket, 2008). This suggests that a large environmental benefit can be gained from optimization of packaging that reduces food losses. It is still unclear though to what extent the package can influence the amount of food loss directly and what will be more indirect causes related to influence on consumer behavior (Williams and Wikström, 2011).

1.1.4 Food and Packaging Waste Handling

The issue of food waste can be divided into two basic problems (Norden, 2011). First, there is the environmental impact from food production that is unnecessary for food that is lost or wasted and not consumed. Secondly, the food that is wasted instead of consumed has to be taken care of in some way. This waste handling adds an extra burden on the environment, especially if deposition in landfills is included (European commission, 2008) – then methane emissions contribute to the global warming.

1.1.5 Waste and Packaging of Bread

Some foodstuffs have been targeted to a larger extent than others in environmental studies. Reasons being mainly their high environmental impact or the magnitude to

which they are lost or wasted. Beef, milk, bread and fresh fruit and vegetables are top candidates on these lists. A study made by WRAP concludes that bread is thrown away in the second largest quantity after potatoes in the UK (Ventour, 2008).

1.2 Problem Discussion

Reports and publications from authorities and highly qualified organizations show that wasted food is a problem with the need to be changed. A substantial amount of food is lost or wasted along the supply chain, from producer to final consumer. This composes an environmental, social and economic problem that at the same time has a large potential to be improved. Consumers' behavior seems to be the main driver but there is also room for improvements from the food industry, especially improvements that can make consumers waste less food. One way to make a change might be to further investigate the possibilities of the food packaging system to reduce food losses.

Still, few studies have been performed on how packaging design affects food waste. Greatest potential to reduce waste in developed countries appears to lie in retail and consumer phases. At the same time it seems important to know why food waste is formed, related to the packaging, in earlier steps of the food supply chain as well. Through investigation of the formation of food waste along the food supply chain it would be possible to sort out factors that can be connected to the packaging of the product.

The packaging will probably have varying possibilities to make a change in the waste of different foodstuffs. Bread appears to be an interesting product to investigate since it is lost and wasted in a large quantity, especially in developed countries. Thus, a reduced amount of waste would make a change. At the same time, bread is a food that is sold both packed and un-packed where the packages of packed products more or less all have the same design. This allows for a search of the bread packaging aspects that can be related to food waste.

1.3 Goal and Purpose

Since food waste constitutes a large environmental problem it would be useful to acquire more knowledge about how and why food is wasted. In this project the focus will be on investigating the food supply chain of bread. The main goal will be to find answers to if the packaging has the possibility to be optimized in order to decrease the amount of wasted bread. The connection between bread waste and packaging will be examined in the stages of production, retail and consumer.

To be able to find answers to the main question several underlying factors will have to be investigated. Questions as the following ones will be examined during this thesis work: When and why is bread wasted in the different steps of the supply chain? How much bread is wasted in the different steps? What happens to the waste? Who takes financial responsibility for the waste? To what degree can the waste be related to the packaging? What packaging aspects can be related to affect the amount of wasted bread? What does the current packaging system look like? All these questions, and more, will be helpful when trying to establish how the

packaging can be related to formation of bread waste. The next step would then be to use these findings in an attempt to optimize the packaging to reduce the amount of waste.

1.4 Delimitations

This project will be carried out during 20 weeks in Lund and Malmö, Sweden. Interviews and questionnaires along the food supply chain of bread will be performed in the local area and with Swedish actors. It will target different parties in the supply chain of bread; producers, retail and end consumers. The goal is to speak with at least three different producers of packed and/or unpacked "soft" bread, three different retailers and 20 consumers. The different actors will be investigated stepwise.

1.5 Disposition

Chapter 1: Introduction – presents the background of the project, discusses the problem and defines the purpose of the thesis.

Chapter 2: Methodology – describes and motivates the methodology applied in relation to data collection and analysis throughout the thesis work.

Chapter 3: Theory – forms a knowledgebase of related topics to make it possible to understand the scope of the problem. Theory in relation to food waste, food packaging and waste handling is presented.

Chapter 4: Results and Discussion – presents results and discusses information gathered in interviews with the different actors in the bread supply chain. The chapter is divided into three sections; bread producers, retailers and consumers.

Chapter 5: Conclusions – presents conclusions that can be drawn in relation to performed work and earlier research.

Chapter 6: Future Aspects – discusses issues and findings interesting to be examined further in the future.

2. Methodology

2.1 Scientific Reasoning

This project summarizes the present situation of bread wastage in the supply chain and tries to find possible theories of how the packaging can be related to the formation of bread waste. To establish this, an inductive method was used, trying to draw general and theoretical conclusions based on empirical data (Wallén, 1996 p. 47; Holme and Solvang, 1997 p. 57). Empirical data is derived from work with real objects or phenomena (Wallén, 1996 p. 62). While approaching a problem using the inductive method, one should endeavor to have an open mind. This could be established for example by applying open interviews in the phase of data collection (Wallén, 1996 p.78). A schematic picture of the research process is presented in Figure 1 to give an overview of the thesis work methodology.

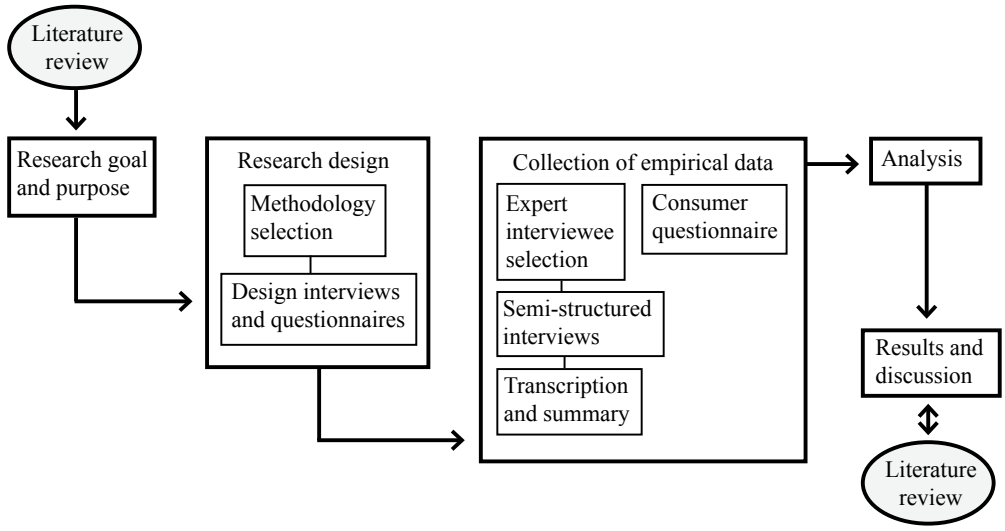

Figure 1. Research process overview.

2.2 Theory and Literature Review

In a first step efforts have been put in a literature review since it is crucial to know the area and current theories in order to identify what has already been done. From this, one can make comparisons and continue to build on previous knowledge (Höst *et al.*, 2006 p.59). Information gathered in the literature review provided an extensive picture of the situation today in the area of food waste and packaging. It formed the ground on which suitable questions for interviews and questionnaires were designed. Together with empirical data, the literature review was used to draw conclusions and make up new theories.

2.3 Qualitative and Quantitative Methods

There are two basic terms to describe data gathered in a survey. Data represented by numbers, numerical values that can be measured goes under the term quantitative data. This kind of data can be evaluated with statistical analysis (Höst *et al.*, 2006 p. 30) and makes generalization possible (Holme and Solvang, 1997 p.81). Qualitative data on the other hand includes details, words and descriptions – it can be identified but not graded (Wallén, 1996 p. 63). An evaluation of qualitative data can be based on the existence, and sometimes frequency, of words and concepts (Höst *et al.*, 2006 p.114). A qualitative method has a depth, trying to describe and understand the problem. A quantitative method utilizes a broader approach to get average, representative data and instead tries to describe and explain the problem (Holme and Solvang, 1997 p.78). The two methodologies can benefit from being used in combination since they reinforce each other (Holme and Solvang, 1997 p.76).

In this research a qualitative methodology was used to explore the production and retail steps in the food supply chain of bread. It was chosen to obtain a broad, descriptive picture of the situation in these two steps of the chain. Previous research has mainly focused on the magnitude of food waste (Naturvårdsverket, 2008; Parfitt *et al.*, 2010; Cox and Downing, 2007; Ventour, 2008) and causes and preventions of waste in different parts of the world (FAO, 2011; Norden, 2011; Parfitt *et al.,* 2010; Cox and Downing, 2007; Ventour, 2008; Williams *et* al., 2012). Detailed information about causes of formation and possible solutions of bread wastage was scarce. By using a qualitative method a close relationship with the source of information could be established. This made it possible to retrieve deep knowledge from experts in the field.

Quantitative data was collected for the last step in the food supply chain, the end consumer. The dialog with consumers was carried out in a stricter and more formal way compared to that with experts in the field, using a face-to-face questionnaire with pre-defined answers. This was to get pure data, facts about for example how much consumers waste, why they waste and their relation to the bread packaging. Later this data was compared with results from previous studies.

2.4 Interviews

Höst *et al.* (2006 p.89-91) state that interviews can be used, as in this project, to gather background material and attitudes. This information can in turn be used to find a possible solution to a problem. Further they point out that interviews can be classified according to their grade of structure. Interviews range from strict structured, similar to an oral questionnaire, through semi-structured to the open interview. An open interview flows with the answers and is highly affected by the respondent's attitude and willingness to talk about different issues.

An interview can be divided into four different parts in order to systemize and make the purpose of the conversation clear to both parties (Höst *et al.*, 2006 p.91-92).

1. Context: state the purpose, how obtained data will be managed in the future and agree on whether the interview is going to be recorded or not.

2. Initial questions: easily answered questions like age, education and work assignments to get the interview going.
3. Main questions: apply a logical order. Move to easier answered questions towards the end of the interview.
4. Summary: the respondent has the possibility to add things, conditions are repeated and it is possible to give feedback.

Kvale (1997, p.85) makes it clear that the qualitative interview is so much more than just the interview itself. The full interview survey can be divided into seven stages, as follows. This way of structuring the work was used as guidance through the planning and performance of expert interviews in this project.

1. Thematization
2. Planning
3. Interview
4. Transcription
5. Analysis
6. Verification
7. Report writing

Lantz (1993, p. 72) explain that qualitative research often can be placed between inductive and deductive methods. Knowledge concerning the problem exists, but not enough to form a theory. When using qualitative interviews the purpose is not to be able to make statistical generalizations, instead it is important to form a ground for deeper understanding. Selection of interviewees is not random; the choices are nevertheless important and will affect the outcome (Holme and Solvang, 1997 p.101).

When designing quantitative interviews it is important to avoid leading and hypothetical questions. It is further an advantage if the questions are kept short, simple, and precise and stated one at a time in a logic manner (Höst *et al.*, 2006 p.87). If the interview requires the respondent to answer in terms of feelings or attitudes, it can be useful to apply measuring scales to get comparable results. In other cases it might be preferable to use the Likert scale. Here the respondent is faced to a statement to which he/she can reply to on a scale varying from strongly agree to strongly disagree (Höst *et al.*, 2006 p.88-89).

Bradburn *et al.* (2004, p.21) states that it is crucial to continuously ask why a certain question is included in interviews and questionnaires throughout the whole design phase. Further, it should be clear how the questions relate to the main research question that underlies the survey.

2.5 Expert Interviews – Production and Retail

2.5.1 Data Collection

Producers and retailers were targeted with semi-structured interviews. This was to create a closer relationship with the information sources while providing a clear way forward for the interviewer, using predefined questions. This method made it possible to discover additional information during interviews that not would have

been identified using a questionnaire with predetermined answer alternatives. Using this method a deep knowledge from experts in the field could be retrieved.

An interview plan was designed, as described by Lantz (1993, p.62-69), with the purpose of working as a support through interviews. Plans for producer and retail interviews are presented in Appendix 1 – Producer interview and Appendix 2 – Retail interview respectively. The main topics used in the interviews, from which subheadings and questions were formed are summarized in Table 1.

Table 1. Main topics that subheading and questions were formed from to make up the interview plan.

Producer	Both	Retail
	Introduction	
Production to retail		Retailing bread
	Bread waste	
	Bread packaging	
	Summary	

The expert interviews were recorded; according to Lantz (1993, p.111) this eases the processing of data. In addition, this makes it possible to go back and listen to the interview again and no important information gets lost due to that it was not written down. Kvale (1997 p. 147) writes that with a tape recorder the interviewer is allowed to concentrate on the subject and the personal dynamics. Further he concludes that a video recorder provides even more extensive information, especially regarding the interaction interviewer to respondent. This was however not seen as necessary and therefore a digital sound recorder was used.

The selection of interviewees was not randomized; instead a deliberate choice was made with the purpose of gathering as much knowledge and qualified information as possible. Employees at three different bread-producing companies were chosen to participate in the study. The names of the companies stay anonymous in this report. The bakeries, each of different size, were located in the southern part of Sweden. The local area was chosen due to time and economic restrictions. A will to cover opinions from different kinds of producers motivates the choice of producing companies with following aspects;

- Participating experts represented companies that produce packed, or packed and unpacked bread.
- The companies are of various sizes and produce from 6 000 ton bread/year or more.
- The different kinds of bread cover the market from being among the cheapest to the most expensive that can be bought in a retail store.

Interviews were carried out during meetings in person at the companies. As is presented in Table 2 employees with responsibility of product and packaging development were interviewed. These people were chosen since they were thought to have the ability to answer the majority of the pre-formed questions.

Table 2. A summary describing attributes of interviewed employees at bread-producing companies.

Question	Company 1	Company 2	Company 3
Gender	Male.	Female.	Male.
Title	Development manager.	Packaging purchasing manager.	Production manager.
Working tasks	Develop new products; bread, packaging and sales points.	Purchase all packaging used in production.	Responsible for production, property as well as planning of production and packaging.
Years of experience in field	14 years with varying positions.	In purchasing business at least 10 years.	35 years. 22 as production manager.
Bread types produced	Packed and unpacked.	Packed.	Packed and unpacked.

People working as managers in three different retail stores in Malmö were also targeted with interviews. Stores with varying levels on price setting were covered in the study. Participating managers knew that data was further going to be published anonymous. These people were interesting since it was probable for them to have a trustworthy picture of the daily wastage of bread in retail stores. Managers who decide about which bread to take away from shelves and those actually throwing products in the trash were considered to carry important information in the retail step of the food supply chain. Additionally, these interviews were probable to give a picture of retailers' view of their relation and contract with producers. Also, since retailers can be considered a link between producer and consumer it was thought to be interesting to examine their role in prevention of bread waste. Table 3 presents an overview of interview participants at retailers.

Table 3. A summary describing attributes of interviewed employees in retail stores.

	Retailer 1	Retailer 2	Retailer 3
Gender	Male	Male	Male
Title	Perishables manager.	Store manager.	Store manager.
Years of experience in field	35 years.	25 years.	35 years.
Type of shop	Shop in city center. Medium-high prices.	Low-price supermarket outside city center.	Supermarket outside city center, low-medium prices.
Bread types sold	Packed, unpacked, bake-off.	Packed, unpacked, bake-off.	Packed, unpacked and in-store produced (not bake-off).

2.5.2 Data Analysis

Qualitative interviews require analysis that is time consuming and not as straight forward as quantitative. In this case the structuring and organization of information has to be done after the interviews have been performed, and there are no exact routines or techniques for how to process the information (Holme and Solvang, 1997 p.139).

According to Lantz (1993, p.73) processing of qualitative raw data is performed with guidance from the interview plan. This plan is formed from the main questions of the interview that in themselves were set from a theoretical pre-knowledge. Thus, this processing form a connection between raw data and the theoretical pre-knowledge as is presented in Figure 2.

When processing information from qualitative interviews it is possible to transcribe central parts word by word and summarize other parts that are of less importance. Afterwards, the shorter written version of the interview can be sent to the respondent to confirm that the information has been reproduced in a correct way (Holme and Solvang, 1997 p.140).

The expert interviews (both producer and retailer) were recorded, and transcribed word by word. Important keywords and phrases expressed by the respondents with connection to the investigated subject were highlighted. This reduction of data can be seen as one step in the analysis (Lantz, 1993 p.79). Then all highlighted information was translated into English and transferred to a table in the same step. Further, a short summary of each topic from the interview plan was made. This was in order to provide an overview and ease the work of comparison and conclusion making. A schematic picture of the qualitative data collection and analysis is presented in Figure 2.

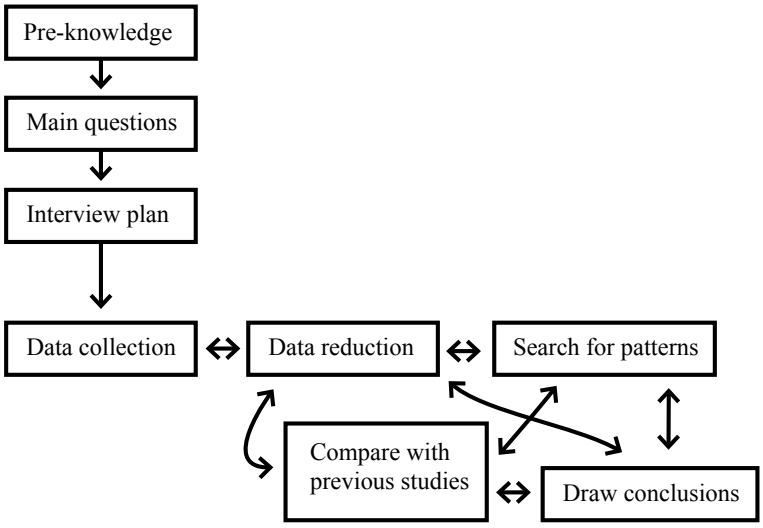

Figure 2. Overview of qualitative data processing.

2.6 Consumer Questionnaires

2.6.1 Data Collection

Consumers have been identified as one of the most important parties in the wastage of food, especially in developed countries (FAO, 2011). Thus it is obvious that a survey of the consumers' view and relation to waste of bread would give important information to understand their behavior. Parameswaran (2003, p. 69) states that quantitative research has to be used if the goal is to investigate behavior and attitudes of consumers. When performing consumer research in the early phase of new product development, questionnaires are frequently used. Creusen *et al.* (2013) establish that this is due to questionnaires giving convincing result in a rather short time. Also, in order to be able to compare the behavior of Swedish consumers with those in earlier studies (Ventour, 2008; Cox and Downing 2007), data had to be collected in a similar way to those studies. Results from the consumer interviews provided a more general picture and were less descriptive than if qualitative interviews would have been used.

Consumers were targeted with strict structured interviews in the form of oral questionnaires, filled out by the researcher. This interviewer-administered questionnaire was used to ease the process of finding participants. A high number of interviewees contribute in itself to increase the quality of the study. This was especially important since a limited amount of time could be spent on consumer interviews. The personal meeting also helped in making sure that the participants understood the questions. Additionally, by using this form of interview, instead of questionnaires sent home to consumers, the problem with internal fall off can be minimized (Wallén, 1996 p.63).

In the consumer survey of this project 50 people were targeted with oral questionnaires. Initially, the goal was to interview 20 consumers – this was by far exceeded. Since time to include more people than planned for at first was available, this was thought of as an opportunity to receive more conclusive results. Consumers were interviewed in five different retail stores in Lund and Malmö; City Gross Malmö, Willys Malmö Katrinelund, Coop Konsum Norra Parkgatan, Ica Malmborgs Tuna and Green Matmarknad.

Figure 3 shows the distribution of consumers targeted at the different stores. Ten consumers were interviewed in each store.

Figure 3. Distribution of consumers interviewed in five different retail stores.

The questionnaire used in the survey can be seen in Appendix 3 – Consumer Questionnaire. It begins with three simple questions concerning the gender, age and number of people in the household of the respondent. Thereafter nine questions and two statements concerning bread, waste of bread and bread packaging follow.

Participants were chosen in food stores at the bread department. In order to receive as representative results as possible, while at the same time assigning a restricted amount of time to the project, some principles were defined. Interviews were carried out in retail stores with varying pricing, located in different parts of town to include various demographic groups. Stores located in central parts of town tend to be smaller and more expensive than stores outside city center. Time of day and day of week when interviews were performed was varied and both males and females in a wide range of age were targeted. Table 4 below presents at what time and day of week consumer interviews were performed in each retail store. Interviews were performed until ten respondents had been collected in each store.

Table 4. A short description of the five different retail stores and day and time consumer interviews were performed at the different locations.

Store	Type of Shop	Day	Time
Willys	Low-price supermarket located in outskirts of town.	Thursday	10.15 - 11.55
ICA Kvantum	Second largest ICA-store, located in outskirts of town but not as low prices as supermarkets.	Friday	12.55 - 14.20
City Gross	Supermarket, low prices and large stores, located outside center of town.	Monday	08.20 - 10.05
Green Matmarknad	Organic and locally produced products, 1400 sq., located in a newly constructed housing area.	Tuesday	11.25 – 13.15
Coop Konsum	Second smallest COOP-store, located in central parts of town.	Thursday	15.35 – 17.40

2.6.2 Data Analysis

Analysis of results from quantitative and qualitative interviews differs. Information is already organized and structured in a way that permits direct analysis in quantitative interviews, and special methods of how the analysis can be performed are available (Holme and Solvang, 1997 p.139). Questions and answers can be translated into numbers and this data can be summarized in tables or diagrams to give a foreseeable picture (Holme and Solvang, 1997 p.197).

Results from all 50 consumer-interviews were compiled using a form designed in Google Drive. Spreadsheets were created and provided the possibility to visualize the summary of responses. Finally, when the analysis was finished, results were summarized and evaluated in relation to the reviewed literature.

2.7 Validity and Reliability

It is inevitable that errors are included in the phase of information collection. Thus an important mission for the researcher is to strive to minimize the errors (Holme and Solvang, 1997 p.164). Kvale (1997, p.213) concludes that information not just should be verified at one step but have to be done so through the whole research process.

Validity of data is dependent on that you measure what you actually intend to measure (Holme and Solvang, 1997 p.163). Meaning that the right questions must be formulated to the interviews in this study. To assure a proper interview design, staff at the Packaging Logistics Department at Lunds Tekniska Högskola read through the expert interviews before they were carried out. In order to get valid results from the consumer survey they were tested in pilot-interviews to assure that questions were understandable and interpreted as desired.

The reliability is decided by how measurements are performed and with what accuracy (Holme and Solvang, 1997 p.163). It would have been desirable to send back summaries of the expert interviews to the interviewees themselves. In this way they could have confirmed that correct interpretations of the information have been made. This reliability check was however not implemented in this project due to time restrictions. In future research it is recommended that time needed for this control is taken in account at an early phase of planning. When it comes to the consumer questionnaires the reliability can be strengthened through collection of a larger number of respondents.

3. Theory

3.1 Structure

This theory section has been written based on the literature review carried out during almost the entire thesis work. Three main parts build up the chapter: Food Waste, Food Packaging and Waste handling. Figure 4 presents an overview of the theory in an attempt to make the structure clearer for the reader. Additional subheadings to those mentioned in Figure 4 are included in the various parts. In several of the underlying paragraphs topics are discussed in relation to three investigated steps of the food supply chain – production, retail and consumer phases.

Figure 4. Main structure of theory chapter.

3.2 Food Waste

3.2.1 Avoidable Food Waste and Environmental Impact

Food intended for consumption has caused a large environmental strain on its way to being suitable for consumption. Thus, for food that is wasted this strain caused to the environment can be seen as totally unnecessary (Eriksson and Strid, 2011). Eriksson and Strid (2011) motivate their choice to investigate food waste in retail stores with the fact that the number of processes applied in vain, increase for each step in the food supply chain. This means a reduction of waste in the end of the chain would have a larger effect compared to that in an early phase.

Production, transport and storage of food impact the environment in varying ways. EEA (2012) has summarized different sources of environmental impact caused by food and drink consumption in EU member countries. Table 5 presents an overview of these sources, coming from agriculture and industrial processing and direct impacts of food consumption. These actions are responsible for most significant environmental impacts caused by food consumption.

Table 5. Most significant impacts on the environment caused by food consumption (EEA, 2012).

Agriculture and Industrial Processing	Direct Impacts
Energy and water use	Travel for shopping
Waste generation in agriculture and processing industry	Energy use for cooking and cold storage
Fertilizers and pesticides	Energy and water use for dishwashing
Emissions from livestock	Generation of food and packaging waste
Land use and transport	
Biodiversity loss from clearance of ecosystems	
Pollution of waster sources	

It has been shown that our food consumption has a substantial impact on the environment. The Swedish Environmental Protection Agency has estimated that about 25 % of the climate change impact from private consumption, which was 80 million ton CO_2 equivalents in 2003, is caused by the activity referred to as "Eating" (Naturvårdsverket, 2008). The Swedish Institute for Food and Biotechnology has concluded that the total food waste from the consumer phase, including households, school kitchens and restaurants, contributes with 1,86 million ton CO_2 equivalents every year (SIK, 2008). Thus, a reduction of food wastage would affect an activity that causes a large part of households' environmental impact.

3.2.2 Food Waste Causes in Developed Countries

As was stated in the background, food is lost or wasted in varying phases of the supply chain in different parts of the world (FAO, 2011). In developed countries retail and consumers have been pointed out as the main source of food wastage (FAO, 2011; Parfitt *et al.*, 2010). Some causes of food wastage in production, retail and consumer phases have been summarized as follows:

- ***Production***

  Wastage in different types of food industries can have several causes and the possibility to reduce the waste varies between branches. Frequently upcoming reasons are damaged raw material, problem in packaging, production errors and switch of product type in the production line (Karlsvärd *et al.*, 2008).

  Some types of food can be returned to the producer, without the retailer having to pay for it. This creates food waste since the retailer lacks incentives to order correctly. In these cases the producers often visit the stores frequently and can in this way adjust the ordered amounts to minimize return rates (Norden, 2011).

- ***Retail***

  Large quantities of food waste in retail stores are formed due to human handling in some way. Interviews have concluded (Karlsvärd *et al*, 2008) that there is a problem with prediction and ordering of the right amount of products. Further, retail strives to meet the expectance from consumers -

filled shelves with a variety of products at all times. Norden (2011) explains that the main reason for food to be thrown away is that it turns "un-sellable". This happens as a result of the combination of the retailer having full shelves and consumers picking the products with longest best before dates.

- ***Consumers***

  Consumers in developed countries are very aware of food safety and demand fresh products at all times. They want to buy products with long date labeling, even if they intend to consume the product at the day of purchase (Norden, 2011). This leads to that large quantities of food that is perfectly fine for consumption are thrown away even before getting sold. Consumers also tend to throw away a large portion of the food they have bought, often untouched in its original package (Lundqvist *et al.,* 2008; Fredriksen *et al.,* 2010).

  Common reasons for wastage of food in households are that too much food was cooked, prepared or served or that the food was not used in time (it looked, smelled or tasted bad, it had passed it date label or become moldy). Consumers, and thus also retailers, demanding attractive products with specific looks results in a significant post-harvest loss (Parfitt *et al.,* 2010). Anyhow, it is not exactly clear why the wastage at consumer level is so high. Possible explanations suggested (Karlsvärd *et al.,* 2008) have been that consumers are not aware that they waste food – at least not in any considerable amounts or that the wastage is seen as something that cannot be avoided.

  In addition to this food can often be bought to a lower price in large packages, sometimes "take three pay for two". Further, smaller portions of food are seldom sold (Norden, 2011) although many people live in single households. This means people might not have the time to finish food before they get inedible. Thus, there are several reasons why food is wasted in households.

3.2.3 Food Waste Quantification

The extent to which food is lost and wasted seems to be difficult to estimate, and varying numbers have been reported. As was mentioned in the background, FAO reports that roughly one-third of the edible parts of food that is produced for human consumption globally gets lost or wasted (FAO, 2011). Another report states quite general that "as much as half of all food grown is lost or wasted before and after it reaches the consumer" (Lundqvist *et al.,* 2008).

- ***Production***

  FAO (2011) has estimated the waste and losses throughout the food supply chain of several different food commodity groups. It can be concluded that the wasting rate varies a lot, from a few percentages up to over 20 for some commodities. There are large differences both between the different steps in the food supply chain and among the investigated commodities.

- ***Retail***

  Norden (2011) presents estimates on the amount of food wasted in the retail sector in Sweden, numbers reaching the level of 83 500 ton during 2008. They further state that most important food groups that are being wasted are fresh fruits and vegetables and fresh bakery products, the same for all Nordic countries.

  In a study made by Eriksson and Strid (2011) food waste in six retail stores in Sweden was investigated. Results showed that on average 0.76 % (weight percentage) of all perishables, out of total amount delivered to the stores, were wasted. This is very low numbers, compared to previous studies. Andersson *et al*. (2010) investigated perishable food waste in three Coop stores, giving results varying between 5.6 % and 3.7 % (value percentage). This shows that the unit of waste percentage together with what types of wastes that are included in the survey can have a large impact on the outcome. Comparison of results from different surveys has to be made with extra precaution to variables like those just mentioned.

- ***Consumers***

  In a study performed by WRAP 2008 it was concluded that one-third of the food bought by British consumers is wasted. Out of this, 61 % could have been avoided if managed better (Ventour, 2008). They state that all consumers waste food and on average people wasted 70 kg/person and year in the study. According to Modin (2011) the annual food wastage per person have been estimated to 56 kg in Sweden, based on studies in Sweden and countries with similar standards of living.

  Another study investigating the waste at food service institutions in Stockholm, Sweden, shows that one-fifth of the food is wasted (Engström and Carlsson-Kanyama, 2004). A Swedish survey (Karlsvärd *et al.*, 2008) estimates that households are the separate largest contributors to food waste but that the total largest quantity of food wastes are formed at other stages in the food supply chain. Even though reported number varies, it can be concluded that the formation of food waste is a substantial problem.

  Further, as is mentioned by Parfitt *et al.,* (2010), food waste rate varies significantly between demographic groups. While being lowest in the elderly, post-war age generation at this point, it cannot be expected to remain such in the future. This since elderly of the future are expected to retain the same behavior and attitude towards food and waste as they apply today.

3.2.4 Future Targets to Reduce the Problem with Wasted Food

In order to deal with the food waste issue several governmental measures have been taken. These targets reinforce the fact that wasted food is a problem. In the European Union a waste directive (2008/98/EG) states that the highest priority is to prevent the formation of waste (Norden, 2011). Further, the United Nations has introduced an initiative to half the amount of food waste until 2025 (EEA, 2010).

3.2.5 Wastage of Bread

To begin with, it can be concluded that the consumption of soft bread in Sweden has increased from slightly below 40 kg/person and year in 1960 to around 55 kg/person and year in 2006. The consumption of homemade bread has decreased - now we buy more products in the stores and the trend with bake-off bread has increased lately (Jordbruksverket, 2009).

Bread, being a cereal product, affects the environment primarily through agriculture and transport. Bread has a relatively low environmental impact, compared to many other foodstuffs (Modin, 2011). On the other hand, bread has been reported to be an item thrown away to a high degree in several countries, especially by consumers (Karlsvärd *et al.*, 2008; Fredriksen *et al.,* 2010; Ventour, 2008; WRAP, 2009; Modin, 2011). This high wasting rate makes the food supply chain of bread interesting to investigate. Especially when keeping in mind that every step that is added in the production of a food means a larger waste of resources when the food is wasted in the later stages of the supply chain. Since consumers are located in the end of the chain and waste a large fraction there might be a possibility to reduce the waste amount and make a change with substantial environmental impact. Further, bread waste quantities and causes in production and retail need to be examined in more detail since information about these stages is scarce.

- ***Production***

  While bread is produced, it is possible to have zero formation of waste in the step where wheat is grounded from kernel to flour. By allowing parts from the kernel not used in the flour to become animal feed, the entire kernel can be utilized (Brödinstitutet, no date). This requires waste going to animal feed not to be considered as waste.

  Karlsvärd *et al*. (2008) describe problems in food production industry related to food waste. In bakeries issues like weight variations, irregular shapes, and bread and dough falling of conveyor belts have been identified to form bread waste. Söderlund (2007) reports that problems like those just mentioned cause a waste of 6 000 ton of bread yearly at Pågen AB, one of the largest producers of bread in Sweden.

  Further, Karlsvärd *et al*. (2008) also point out that the distance between producing industry and end consumer might be a problem. This is by making it hard for producers to realize what requests consumers have regarding packaging and new products.

  Söderlund (2007) describes that producers of bread want to make sure they can deliver ordered amounts to their customers. In order to do this, while having unforeseeable losses in the production, they often produce more than the calculated order. This overproduction formed 520 ton of bread waste at Pågen AB in 2006.

- ***Retail***

  Retailers fight the problem of having full shelves at all times, while at the same time aiming to sell all their products (Karlsvärd *et al.*, 2008). Consumers' demands on fresh products have increased and they are not keen to buy foodstuffs with short dates.

  As have been mentioned before it is difficult for retailers to predict and order the right amounts of products. This problem has been identified as one of the main reasons for bread waste formation in retail stores (Karlsvärd *et al.*, 2008). Additionally, some unsold products, among them bread, can be returned to the producer - without any extra cost for the retailer (Norden, 2011). In this way the retailer doesn't have any economical incitement of correct and more careful ordering. According to Söderlund (2007), Pågen AB received six percent of all produced bread in return from retailers during 2006.

  Another study presents that shops produce seven percent more freshly baked bread than they expect to sell. This is in order to meet the criteria from the customers - filled shelves and availability of fresh products at all times (Norden, 2011).

- ***Consumers***

  One survey concludes that in Norway, fresh fruits and vegetables together with bakery make up the largest part of food wasted in households (Fredriksen *et al.,* 2010). In this study analysis of household food waste from Fredrikstad, Norway, showed that 27 % of the waste was made up of bread and bakery products. It was further concluded that more than 50 % of the bread thrown away was in its original package. The bread thrown away were mostly slices and pieces thinner than 3 cm (69 %).

  The Consumer Association of Stockholm asked the following question in a survey: "Have you thrown away any of these foodstuffs the last week?" Respondents were asked to answer the question for ten different food items ranging from bread to vegetables, egg and dairy products. Bread and bakery products placed in top of the list; with 41 % of the respondents answering they had thrown this foodstuff the last week (Consumer Association of Stockholm, 2009).

  Parfitt *et al.,* (2010) have summarized household waste composition from five different surveys across five countries. The result is presented in Figure 5 and shows the amount of different kinds of foodstuffs, like dairy, meat, bakery produce and fresh vegetables and salads. These results can be used to point out the variation in both waste composition and types of foodstuffs that are thrown away in largest quantities. Bread, including in bakery products, made up a significant amount of the wasted food. Due to cultural food consumption variations the amount and type of bread consumed varies between different countries, this does also affect the amounts that are wasted.

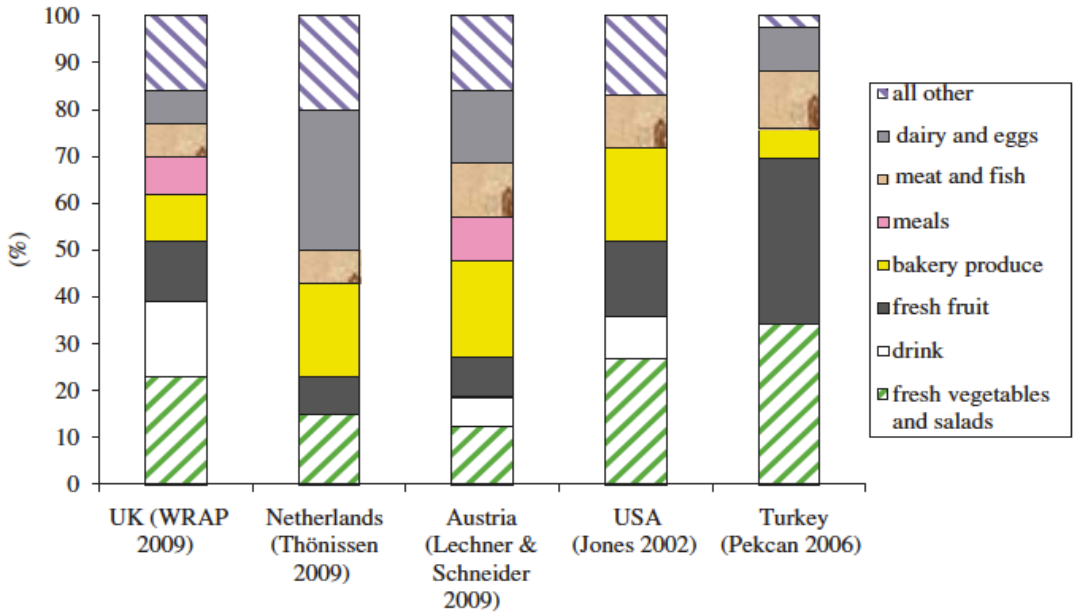

Figure 5. Results from five different surveys examining the composition of household food waste (Parfitt *et al.*, 2010).

WRAP, an UK organization founded in year 2000 work to reduce the amount of food and packaging ending up as waste. It is a not-for-profit-organization funded by governments in England, Scotland, Wales and Northern Ireland (WRAP, 2013). WRAP has directed a lot of resources on studies with consumer perspective, among others "The food we waste" (Ventour, 2008) and "Food behaviour consumer research: quantitative phase" (Cox and Downing, 2007).

With the study by Ventour (2008), WRAP aimed to collect information of why food is thrown away in households. By letting consumers register in kitchen diaries, every time they threw away food, the type of waste, amount and reason for disposal was recorded. 284 UK households participated in the exercise.

The study concludes that in the UK, bread is thrown away in second largest quantity after potatoes (Ventour, 2008). The total annual standard bread waste in the UK is 660 000 ton, of this 540 000 ton is avoidable waste (avoidable meaning thrown away food that was edible some time prior to the disposal). This means 29 % of all standard bread purchased was wasted (WRAP, 2009). As is presented in Figure 6, the WRAP study presents main reasons consumers gave to why they wasted bread. The bread was out of date, the bread looked bad, went moldy or was left on the plate were frequent answers (Ventour, 2008).

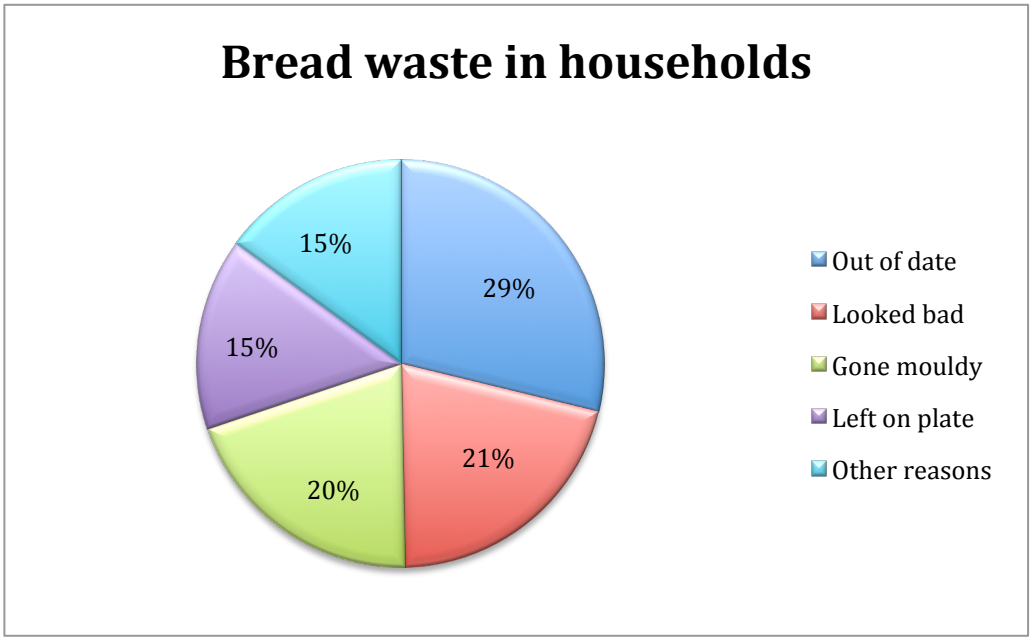

Figure 6. Reasons given by UK consumers on why they waste bread in their households (Ventour, 2008).

With the study by Cox and Downing (2007), "Food behaviour consumer research: quantitative phase", WRAP aimed to explore household food behavior in the UK. They wanted to find answers to questions like how much consumers say they waste, which groups of consumers that are more likely to waste etc. 1862 interviews were carried out face-to-face in the homes of representative British consumers.

Cox and Downing (2007) asked participants to state how much bread and cakes they waste. Anwers were distributed as follows; Significant (quite a lot, a reasonable amount, some) – 20 %, Moderate (a litte) – 16 % and Minor (hardly any, none) – 64 %.

Further, Cox and Downing (2007) examined consumers´ relation to the date labeling on food stuff. On the question: "Think about how you use the dates on the labels of food products which indicate how long the product will last for, which of the following statements best describes you?" for bread and cakes, the following results were obtained.

- I never eat past the date on the label. 56%
- I occasionally eat past the date on the label. 32%
- I often eat past the date on the label. 9%
- I don't look at the date on the label. 2%
- I don't know. 1%

Cox and Downing (2007) also made the participants face two statements and decide to what degree they agreed or disagreed. Results are presented in Table 6. The statements were as follows:

1. Discarded food packaging is a greater environmental issue than food thrown away.

2. Food waste thrown away is not an issue since it is natural and biodegradable.

Table 6. Answer frequency on the two statements above, 1 and 2. Respondents were asked to decide to what degree they agreed or disagreed, results are given in percentages of the total amount of respondents.

Statement	Strongly disagree (%)	Tend to disagree (%)	Neither agree nor disagree (%)	Tend to agree (%)	Strongly agree (%)
1	3	6	18	29	44
2	14	23	24	27	12

3.3 Food Packaging

3.3.1 Food Packaging Systems

The packaging of a food product can be regarded as a system at different levels: primary, secondary and tertiary. These levels have varying functionalities in relation to the product, distribution and consumers (Krochta, 2006). Table 7 summarizes the food proximity and main functions of different packaging levels.

Table 7. Functions of different packaging levels in a food packaging system (Krochta, 2006).

Level of packaging	Proximity to food	Main function	Packaging example
Primary	Direct contact.	Main protection against environment. "Retail packaging".	Plastic bag with clip for bread.
Secondary	Hold primary packaging/unitizing several primary packages.	Add protection against physical abuse. "Retail/distribution packaging".	Corrugated board boxes for transportation of bread.
Tertiary	Hold secondary packaging/unitizing several secondary packages.	Contain and protect during storage, transport and distribution. "Distribution packaging".	Plastic wrapping and metal racks for transportation of breadboxes.

3.3.2 Basic Food Packaging Functions

Food packaging systems have to fulfill a number of basic requirements. The most relevant functions of a food packaging have been summarized as follows (Lockamy, 1995):

- Containment – to hold the product.
- Protection – protect the product from outside environmental chemical, biological and physical hazards.
- Apportionment – provide manageable portion sizes for end consumers.
- Unitization – allow for primary packages to fit into secondary that in turn can be unitized into tertiary packages.
- Convenience – simplify the use for end consumers.
- Communication – for recognition, traceability, and information about content.

3.3.3 Food Packaging Legislation

The European Union Directive 94/62/EC regulates packaging and packaging waste (European Council, 1994). It covers all packaging that have been placed on the European market and is intended to harmonize national measures concerning handling of packaging and packaging waste. Prevention of packaging waste has first priority. Directive 94/62/EC also provide provisions regarding re-use of packaging and recovery and recycling of packaging waste.

Voices have been raised concerned about that the focus has been on recyclability and reduction of the amount of packaging material for too long. Instead, the main purpose of packaging – to preserve and protect the product, should have a more central position (Williams *et al.,* 2008). To minimize the amount of packaging waste might not be the right way to develop the packaging functions - in some cases a reduction of packaging material might even increase the losses at the consumer end or earlier in the chain (Wikström and Williams, 2010; Karlsvärd *et al.*, 2008).

In a report written for the Swedish project "Klimatmärkning för mat" (Climate labeling of food) (Nilsson *et al.*, 2009) important legislations concerning food packaging in Sweden have been summarized. Table 8 presents these legislations together with an update according to 10/2011/EC (European Council, 2011).

Table 8. Important legislations regarding food packaging in Sweden (Nilsson *et al.*, 2009; European Council, 2011).

Legislation	Number	Content
Directive	94/62/EC	Packaging and packaging waste.
Regulation	1935/2004/EC	Rules regarding materials and products meant to come in contact with the food.
Regulation	2023/2006/EC	Rules for good manufacturing of materials that will have contact with food. List with materials approved to have contact with food.
Regulation	SFS 2006:1273	Responsibility of parties who produce, import or sell a packaging to collect and recycle. "Polluters Pays Principle"
Regulation	282/2008/EC	Rules for using recycled plastics in contact with food.
Regulation	10/2011/EC	Materials and products of plastics meant to come in contact with food.

According to regulation 282/2008/EC there are certain quality standards on recycled plastics in order for them to be applied in contact with food. The recycled plastic should have the same quality as virgin plastics in order to be used in contact with food (Nilsson *et al.*, 2009). Further, companies using recycled plastic materials in their packaging have to state this on the packages.

3.3.4 Influence of Packaging on the Environmental Impact of a Foodstuff

Packages of food influence the total environmental impact of the packaging-food system in many aspects, not only the most obvious ones like impact from the material itself. Wallman and Nilsson (2011) have summarized functions of the packaging with influence on the total environmental impact as follows:

- Packaging material.
- Material production process.
- Packaging waste handling.
- Protection of food.
- Food waste caused by packaging.
- Transportation requirement (weight and design).

Further they highlight the importance of regarding the food and packaging as a system when developing an optimal design. Wallman and Nilsson (2011) continue to line up properties characterizing a climate-smart packaging (see Table 9).

Table 9. Properties characterizing a climate-smart food packaging (Wallman and Nilsson, 2011).

Aspect	Property
Function	Protect and provide good keeping qualities.
Material – type	Petroleum based release fossil CO_2, cellulose based doesn't. Possibility to use recycled material.
Material - amount	As small as possible – without affecting the packaging functions.
Energy choice	Renewable energy sources in processing.
Packaging design	Total emptying possible. Efficient storage and transport.
Packaging size	Large packages have smaller ratio packaging material to weight of food product than small. Consider that large packages might lead to increased amount of waste.
Transportation work	Shape, strength and weight per product weight. Consider transport before filling and during waste handling.

3.3.5 Packaging Role in Prevention of Food Waste

It has been confirmed in several studies (Williams *et al.,* 2012; Cox and Downing 2007) that in the public debate it is often the packaging material that is seen as the most important environmental issue. They report that consumers believe packaging waste is more hazardous than food waste for the environment. A lot of people seem to believe that food waste is not an environmental issue since food is biodegradable (Cox and Downing, 2007). This while the reality shows that the packaging itself mostly make up for only a few or 5-10 % of the environmental impact from the whole food-packaging system (Hanssen, 1998; Wikström and Williams, 2010; Fredriksen *et al.,* 2010). There is one study that argues for emphasizing of the section in the EU directive concerning functions of packaging instead of the recent priority on packaging minimization (Williams and Wikström, 2011). Further the same authors suggest that the packaging ability to preserve food should be included in future directives (Williams *et al.,* 2008).

As was mentioned in the background it has been reported in several studies that packaging has an important role in the prevention of food waste (Norden, 2011; Williams *et al.,* 2012; Karlsvärd *et al.*, 2008). Optimal packaging instead of minimal was mentioned as a suggested action to reduce the amount of food waste (Norden, 2011). Another study reports that 20-25 % of household food waste can be related to the packaging, and even though consumer behavior will determine the final outcome, better packaging and information can contribute to a reduction of food waste (Williams, *et al.,* 2012). In the best case a new packaging has both lower environmental impact than the old and the ability to reduce the amount of food waste. Sometimes however, it can even be advantageous to increase the environmental impact of the packaging itself in order to receive a better packaging that reduces the amount of food wasted. In this way the total environmental impact from the food packaging system can be reduced. This is especially true for food with high environmental impact like meat and dairy products and food with substantially amount of losses like bread (Williams and Wikström, 2011). Wikström and Williams

(2010) have established a model for calculation of the environmental impact of a food packaging system as a function of food losses.

A study made by Williams *et al.* 2008 suggests that consumers think quality attributes of packaging are important aspects (according to Kano's Theory of Attractive Quality). Must-be attributes, for example leakage, packaging date and best before date have also shown to be connected to food waste (Williams *et al.,* 2008). If these must-be attributes are unfulfilled the result is not only dissatisfied customers but also a larger quantity of wasted food. The study shows that there are obvious potentials to decrease the environmental impact from the food packaging system and receive satisfied consumers – especially if the packaging design allows for reduced food losses.

Specific packaging aspects that can be linked to food waste have been investigated in several studies. Williams *et al.* (2012) found the following packaging aspects linked to food waste: too big packages, packages that are difficult to empty and wastage due to passed best before date. Further, 14 of 24 attributes on packaging like packing date and best before date, resealability and total emptying has been noticed to reduce the amount of waste (Williams *et al.,* 2008). Packaging sizes that meet the demands from all households, improved date-labeling and storage instructions are some measures that can be taken to prevent losses in relation to the package. Improvement of food labeling and consumers' understanding of labeling has been proposed as additional actions to reduce food waste. Further development of packaging design can contribute to prolong shelf life of products (Parfitt *et al.,* 2010).

3.3.6 Future Food Packaging Targets

One suggestion to ease and speed up the prevention of food waste has been to trigger the packaging industry to develop packaging that is well suited for its purpose (Karlsvärd *et al.*, 2008). Food packages should be easy to empty and at the same time protect its content. Transport packages are especially important to consider since standardization can ease the handling and thus prevent formation of food waste (Karlsvärd *et al.*, 2008).

It has been stated that there is a need for a more holistic and systematic environmental perspective when developing new packages (Svanes *et al.,* 2010). Until recently companies have often focused on two properties of the packaging like low ratio of packaging weight to product and the avoidance of specific materials (Svanes *et al.,* 2010).

A Norwegian study summarizes measures that can be taken in relation to the packaging to reduce the amount of food wasted in households (Fredriksen *et al.,* 2010).

- Increased availability of smaller portion packages, as the number of smaller households has increased lately[1].
- Improved opening and resealing mechanism can contribute to preserve the product.
- Easier emptying of packages like yoghurt and sour milk would allow for total emptying.
- Packages with modified atmosphere or protective barriers could prolong shelf life of products.

3.3.7 Packaging for Bread

As bread is the product category in focus of this project, here follows a description of the packaging's role and aspects in the bread-producing industry.

- ***Packaging Impact on Bread Quality***

  Main functions of bread packaging can be described as those for foodstuffs in general; listed in section Basic food packaging functions. When it comes to the quality of bread, packaging act as a protection and gives the bread a prolonged shelf life. Galić *et al.* (2009) conclude that shelf life of bread, meaning retaining an acceptable quality regarding safety and from an organoleptic (aspects experienced by our senses e.g. taste, smell etc.) point of view, depends on four factors. Packaging has been pointed out as one of these factors, and the other three being formulation, processing and storage conditions. Galić *et al.* (2009) further explain that use of packaging can reduce or delay texture and flavor changes to some degree and in this way provide an acceptable product for a longer time.

  The aging process of bread, causing textural changes is called staling. Textural changes are due to retrogradation of starch resulting in a dry, hard and crumbly interior (McGee, 2004 p.541-542). When starch retrogrades, amylose and amylopectin chains recrystallize and water migrates out of the granules. As time goes on more water is expelled from the granules and starts to migrate from the surrounding gluten in the interior towards the crust (McGee, 2004 p.542). Figure 7 presents how the moisture content in different parts of bread changes with time after baking. Staling is often thought to be a simple process that dries out the bread, but it will appear even in a closed container. It can be described as a process in two phases (Coultate, 2009 p.57). First the simpler, straight amylose chains retrograde, within a few hours after baking. This creates an initial firming that ease the process of slicing the bread. Secondly the more branched amylopectin chains begin to crystalize but in a much slower rate, due to their irregular structure. They expel water during several days and the result is stale bread (Coultate, 2009 p.57; McGee, 2004 p.541-542).

[1] In Sweden 24.3 % of the population lived in single households 2011, to compare with 21.5 % in 1991 - an increase with 13 % (Statistiska centralbyrån, 2013).

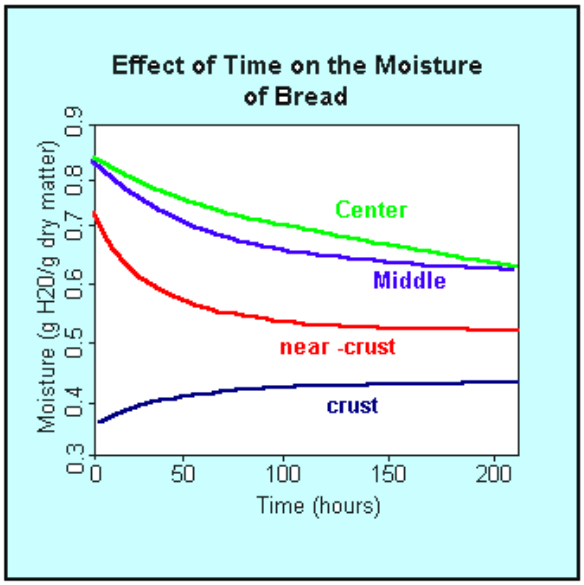

Figure 7. Moisture content variation with time after baking in the centre, middle, near-crust and crust of a loaf (University of British Columbia, no date).

It has been concluded that bread quality is strongly affected by the microenvironment in the packaging. Galić *et al.* (2009) state that it is dependent on the gas composition, relative humidity and pressure or mechanical stress inside the package and light and temperature in the surrounding environment.

One quite obvious external factor decreasing the quality of bread is microorganisms. According to Cioban *et al.* (2010) bread is commonly composed of 40 % water, resulting in a water activity of 0.96. This means it is readily receptive to a mold attack. Additionally, when storing bread in a plastic bag in room temperature, moisture from the staling starch is accumulated on the bread surface (McGee, 2004 p.542-543). This can enhance the growth of potentially toxic molds like blue-green species of *Aspergillus* and *Penicillium*.

- ***Bread Packaging Material***

Choice of material suitable as packaging is based on several underlying factors. Galić *et al.* (2009) have summarized these aspects as economy, marketing, logistics, distribution, consumer demands and the environmental impact of the packaging.

Further, if choosing packaging for bread packed in the production line, one has to take in consideration that this usually is done when the bread still is hot. As Pagani *et al.* (2006) explains, this demands the packaging to have a rapid heat exchange with the environment and allow for evaporation of water. This to avoid formation of condensate on the inside – that would result in early softening and form an ideal environment for growth of microorganisms.

Packaging for bread can be seen as a system at different levels, as was described in section 3.3.1 Food Packaging Systems. There are a lot of materials with different gas and water permeability available. The Swedish Food Agency presents what materials that are used in the most common primary food packages (Wallman and Nilsson, 2011). According to this, polypropylene (PP) (and also polyethylene (PE)) plastic bags are frequently used as primary packages in the packed bread industry. These bags are then packed into corrugated board boxes or hard plastic boxes, piled in transportation racks and delivered to retailers. If sold unpacked, bread can be transported in the boxes wrapped in a large plastic bag or with paper in bottom and on top to allow circulation of air. Then consumers themselves get to wrap the bread into a paper bag in retail stores.

There are several differences between PP, PE and paper properties, especially when it comes to the permeability of gas and water (Cioban *et al.,* 2010). PE has good mechanical resistance and permeability to gases and high impermeability to water vapor. PP is more see-through and has better mechanical resistance than PE. PP has lower permeability to water and gas than PE. As Pagani *et al.* (2006) states, paper makes sure there is an exchange of gases with the environment. In order to make paper bags resistant to water they can be coated with e.g. a plastic film.

McGee (2004, p.542) summarizes one section about storage of bread. To retain a crispy crust on newly baked bread for a day or two, McGee suggests that a paper bag is used – it reduces moisture loss from the interior while providing a crispy crust. On the other hand, to keep the bread for several days he suggests wrapping it in plastic and freezing it. A plastic bag will prevent transfer of water from crust to the surrounding – water will remain in the crust. The process of staling has its maximum rate at slightly above freezing temperature. Storage in refrigerator is due to this not to prefer, if toasting or reheating is not to be applied at a later stage.

- ***Legislation***

  The Swedish Food Agency has summarized current rules regarding labeling of packed bread, as a guidance for bread industries (Livsmedelsverket, 2007). Table 10 presents a summary of mandatory and optional labeling of bread. Designation, net quantity and best-before date are required to be possible to see in the same visual field.

Table 10. Mandatory and optional information for bread labelling (Livsmedelsverket, 2007).

Mandatory information	Optional information
Designation.	Storage instructions.
Ingredients list; amount; allergens.	Day of production.
Nutritional content – if health claims included.	Nutritional and health claims.
Net quantity.	"Keyhole" symbol.
Best –before date.	Nutritional content – if no health claims.
Name and address of producer, packaging or seller.	Origin.

- ***Packaging impact on wastage of bread***

A lot of packaging aspects have been identified in relation to the amount of wasted food in general (Williams *et al.,* 2008; Williams *et al.,* 2012 and Parfitt *et al.,* 2010). When it comes to bread in particular information on packaging features related to waste was somewhat scarce. The large quantities of bread in household waste might imply that there is a need for smaller packages (Karlsvärd *et al*., 2008). In this way the chance of consumers finishing the package before it passes its best before date increase. Another measure could be to inform and encourage consumers to freeze parts of the bread in order to avoid it ending up in the waste. This could be done on the packaging or in the store at the bread department (Karlsvärd *et al*., 2008).

Date labeling of bread has shown to affect the behavior of consumers. If the labeling system could be modified in some way there might be a chance to lower wasting rates. In a survey made by the Consumer Association of Stockholm 1196 Swedish people replied to a net-based attitude survey with questions regarding date labeling and waste of food. One third of the respondents totally agreed that passed best before date often is the reason they throw away food. Additional 24 % partially agreed to this statement. Further, this survey showed that 62 % of the respondents would prefer a labeling with "at least preservable until" instead of "best before". This since that kind of label best shows that the food can be perfectly fine for consumption even though best before date has been passed (Consumer Association of Stockholm, 2009).

It has been shown that the energy use for production of a bread package can be allowed to increase up to 2.3 times if the amount of wasted bread as a result is reduced with 10 percent units (Williams and Wikström, 2011). This 2.3 times increase is however not wanted and Wikström and Williams (2010) suggests that such high increase is not required to achieve reduction of losses. Further they conclude that the ratio (2.3) is even higher for products like beef and cheese with larger environmental impacts from the production. Finally they state that bread, however, is interesting to investigate anyway since it is wasted in such large quantities.

3.4 Waste Handling

Fredriksen *et al*. (2010) state that it is ten times more beneficial to prevent formation of food waste than to treat the waste with the most environmental and resource efficient methods. To prevent formation of waste is top prioritized in the waste handling hierarchy applied in EU countries (Avfall Sverige, 2012; European Council, 1994). At this point though, a lot of food and packaging waste is formed. Thus, selection of food and packaging waste handling techniques are important for the total environmental impact of the food-packaging system.

Producers are responsible for waste management costs of their packaging and municipalities covers household waste management. Households are obliged to sort their waste, turn it in to the existing waste management systems and to follow waste handling regulations in their municipality (Avfall Sverige, 2012).

3.4.1 Food Waste Handling

Reduction of food waste has been estimated to prevent the environmental burden from millions of tons of CO_2-equivalent emissions each year, the question being how this can be done. Primary actions could be linked to changing consumer behavior and retail policies (European commission, 2008).

Food waste handling methods applied varies in different parts of the world. In those areas where handling methods include landfilling with anaerobic conditions it is crucial to develop packaging that can reduce the amount of wasted food (Wikström and Williams, 2010).

Wikström and Williams (2010) report that when energy has to be added in the waste handling process of food, e.g. waste incineration or landfill, there is a greater environmental potential to find new packaging solutions. This is when compared to cases where food waste can be recovered as energy and replace another energy source, e.g. biogas production.

- ***Food Waste Handling in Sweden***

  According to Avfall Sverige (2012) the amounts of collected waste in Sweden increased in year 2012, this after a few years decline. The separate collection of food waste is, to the better, increasing. At this point about 60 % of Swedish municipalities provide separate food waste collection. Most common is that there are two different vessels, one for food waste and one for combustible waste, available for waste separation. Systems with vessels separated into several compartments and optical sorting of different colored bags are also available.

  Further, environmental goals set by the Swedish parliament have reduced the amounts of food deposited in landfills from five percentages in 2005 to less than one percent in 2011. In May 2012 a new goal was set to increase resource usage in the food supply chains. At least 50 % of food waste from households, food services, retailers and restaurants should be sorted out for biological treatment latest 2018. The trend goes towards more and more treatment by anaerobic digestion than composting.

3.4.2 Packaging Waste Handling

Packaging waste handling methods are also important to take into account when considering the environmental impact from the whole food-packaging system. Material recycling of packaging reduces the environmental impact and saves energy and raw material resources (Avfall Sverige, 2012).

It has been suggested that when the package is incinerated with heat recovery it can be beneficial to increase the amount of packaging material and waste handling to reduce the amount of food waste (Wikström and Williams, 2010).

According to Wikström and Williams (2010) the potential to develop packaging that reduces the amount of wasted food is greater in areas with efficient packaging recycling methods. On the opposite, in areas where waste handling of food is efficient and recycling of packaging has a lower frequency, the authors argue that it might be more acceptable to have a higher degree of wasted food than to increase the amount of packaging (from an environmental perspective).

It is also important to remember that there are laws regulating the usage of recycled plastics in food packages. EU directive 2002/72/EC regulates the usage of plastic materials that are intended to have contact with food. Polyethylene terephthalate, PET, is a material that can be used in contact with food when recycled. Other recycled plastics have been used in laminates and such surfaces that have no contact with the food (Wallman and Nilsson, 2011).

- ***Packaging Waste Handling in Sweden***

  In Sweden the law of Extended producer responsibility for packaging was introduced in 1994, nowadays regulation 2006:1273 (Förpacknings- och tidningsinsamlingen, 2013). It is based on the "Polluter pays principle". Hereby the responsibility for waste management cost was shifted from municipalities and taxpayers to producers and consumers.

  According to Förpacknings & Tidningsinsamlingen (2012) 54 % of all plastic packages were recycled in Sweden 2011. Out of this 26 percentage points goes to material recycling and 28 percentage points to energy recovery. The governmental goal is to achieve a level of 70 % recycling of plastic packages in total, whereof 30 % should be material recycling.

  Main fractions of recycled packaging material are collected at the unattended recycle stations, run by producers (Avfall Sverige, 2012). Larger apartment houses sometimes have a close-by recycle station where packages are collected. Soft plastics should be sorted out into the same container as hard plastics since 1st of November 2008 (VA SYD, 2012 a).

3.4.3 Waste Handling of Bread in Sweden

In those municipalities providing separate waste handling of food, bread from households should be sorted into this system. Otherwise it goes into household

waste for incineration. The plastic bread bags should be sorted into soft and hard plastics and paper bags from unpacked bread into paper packaging (VA SYD, 2012 b).

Numbers on recycling rate of bread packaging have been difficult to find. Anyhow, the investigation of household food waste made by Karlsvärd *et al*. (2008) showed that more than 50 % of wasted bread was still in its original package.

Bread that is taken back from retail can be mixed with unsellable, overproduced and other bread waste from production. As Norden (2011) explains, it costs more work to empty packages and send to animal feed than to incinerate both bread and packaging. This might affect the waste handling methods chosen by each producer.

As Wikström and Williams (2010) reports, if bread ends up in landfills with anaerobic conditions, the global warming impact of the bread waste is much greater than that of the bread packaging waste.

4. Results and Discussion

The result and discussion section is divided into three parts; Producers, Retailers and finally Consumers. Results from interviews are presented and followed by a discussion and comparison with existing literature.

4.1 Expert Interviews – Producers

4.1.1 Introduction

Interviews with managers responsible for packaging were performed during personal meetings at three different bread-producing companies acting in the southern part of Sweden. The interview guide used during producer interviews is presented in Appendix 1 – Producer interview. The following text presents results from the producer interviews, divided into sections in the same order that questions were posed during the interviews, using subheadings to separate different topics. After result presentation a section with discussion and comparison with other literature follows, using the same subheadings as the result part. In the end of chapter 4.1 a summary describes the main findings from the producer interviews. Below a description of the structure is presented.

4.1.X Section 1 – Results

Subheading 1

Subheading 2

4.1.Y Section 1 – Discussion

Subheading 1

Subheading 2

Master theses are public documents and in this project information from expert interviews are anonymously presented. This was thought to ease gathering of information and make the participants share their thoughts. However, interpretation of information might affect the results. Thus, in the future, results should preferably be sent in return to interviewees for affirmation of correct interpretation.

Since interviews were carried out in personal meetings the information handled during the conversation might have been affected by how the interviewer and the respondent interacted. Difference in age and the fact that the interviewer was a young female student with no experience in the field might have affected what kind of information the managers choose to share. Some information might have gone lost because the interviewees presumed certain information was common knowledge. It was assumed though; that shared information was more extensive since participants knew information was going to be published anonymous than if this would not have been the case.

4.1.2 Production to Retail – Results

Production and Ordering

For bread suppliers to produce the appropriate amounts of bread they have to consider many different factors. First, there might be some losses during the production itself, but the largest challenge is to know how much that is going to be sold later in retail stores. This has to do with placement of orders. Then there are difficulties with producing an exact number of bread, with an unforeseeable loss during production.

When it comes to ordering all three participating companies had varying approaches. One company leaved ordering mostly up to stores themselves. For another company it varied between stores whether the retailers ordered themselves or if they handed it over to the salesman. It did however seem to be up to the retailer to choose the ordering approach. At the third company, their own salesmen handle all ordering. It seems like a standard measure for salesmen to have a fixed salary plus provision. If their return rates exceed a certain limit their provision is decreased. In this way producers can make sure that salesmen order responsibly.

Estimations of sales rates have to be performed continuously since it varies with weather, season, trends and moods of the consumers among many things. Return rates, unsold bread taken back from retailers to producers, from earlier deliveries together with sales rates can be utilized to make prognoses. Interviews show that two out of three producers have the possibility to obtain information from cashier systems in some retail stores. For the third one this was not possible.

Delivery

The producing companies themselves perform delivery of products to retailers and other actors. Interviews showed that employees making the deliveries, the truck drivers, have a wide variety of tasks to perform. They are namely also the salesmen at the company. They start by loading their truck, deliver bread to the different stores in their region, unpack and fill shelves in stores, take new orders, bring back returns and finally off-load their truck back at the production site.

4.1.3 Production to Retail – Discussion

Production and Ordering

It was somewhat strange that two retailers participating in interviews said that producers order bread themselves, see 4.2.2 Retailing Bread - Results section “Ordering of bread”. This since products from the company who make retailers place orders are sold in all three retail stores. Yet, two of three retailers claimed salesmen place the orders. This was a bit contradictive. It might be that the person interviewed at either the producing company or the retail store had wrong information on this subject.

The producer who not receives retailers cashier info has highest return rates, by far. This might imply that receiving this information is really important in order to

estimate future sales rate and keep down return rates. The same producer did however also have the shortest time frame allowed for bread to be placed on shelf. This can explain some of the amounts wasted in excess when compared to other companies. One can wonder though why not all producing companies have access to the cashier system information. Questions that would be interesting to investigate further are whether this exchange of information is controlled in the contracts? Do producers have to pay or give something in return for this information? What do retailers lose on not providing producers with this information?

The estimation of how much bread that is going to be sold and thus should be ordered would be hard to do regardless if the full rights of return existed or not. Either would the producer care most about getting the right orders or the retailer would, meaning the one with financial responsibility would care most. Maybe, if both parties had been responsible for the returned bread (in another way than that retailers only lose money if returns exceeds a certain limit) they would be able to work together in a more efficient way when it comes to predicting sales rates. It might be hard to accomplish this as long as only producers have almost all the financial responsibility for the waste. Especially since they might not care that much about the waste, they can increase the price on their products to compensate for losses – meaning that consumers in the end pay for both the bread they purchase and the waste, probably without realizing it.

Delivery

The employees delivering bread showed to have a much larger responsibility in the supply chain than what was expected on beforehand, especially at two of three companies. It was them who dealt with unpacking and refilling and removal of bread on shelves. In the future it would really be interesting to make the same kind of expert interview with them. Especially since many of them work as salesmen and they are the link between production and retail, the phase where the largest fraction of bread waste seems to be created.

4.1.4 Bread Waste – Results

Formation of Bread Waste in Production

All participating managers knew how much bread waste that is formed during production. It varied from 1 % to 2.5 % of all produced bread.

From the interviews it can be concluded that there are two main types of bread waste formed during production. First there is the kind of waste that is formed due to incorrectness in production. This can be things like uneven baking, deformation, sliced crusts thrown away, flour on the floor, packaging stuck in the machine, broken packaging bags, bread that doesn't fit into bags, scale incorrectness or other factors that influence the appearance or destroy the bread. Secondly, there is another type of waste formed simply as a result to that just mentioned. It is hard to produce an exact amount of bread since some errors resulting in waste always can appear during production. Thus, producers usually produce a certain amount in excess to the orders to be sure they always are capable of delivering according to ordered

amounts. This overproduction also results in waste when less bread is wasted due to errors in production than what was expected on beforehand.

All managers proclaimed that even if a lot is automated in the production, there is always a person behind each machine that can make mistakes. Together with external factors, like humidity, moisture content of flour and water temperature the fermentation is affected. Basically, there are a lot of different things that are needed to work together - thus bread can be wasted due to many different reasons.

Difference Between Packed and Unpacked Bread

Managers from companies producing both packed and unpacked bread stated that the amounts of waste are similar between the two types of bread. The reason for waste formation can on the other hand vary. When it comes to unpacked bread there are no problems with slicing or packaging getting stuck in the machine or cracking in welds but there can be problems with for example deformation.

Producers Interest in Reducing Waste

When producing managers were asked if they consider bread waste formation in production as an issue answers varied. One said “yes”, another “no” and the third explained that they work to keep down waste amounts since it costs money. All three did however state that they work to keep the wasted amounts in production as low as possible.

Prevention of Bread Waste Formation in Production

Managers were asked about their company’s prevention of bread waste formation and all stated they work with reduction of waste. One company hired a quality manager that works with lean (preserving value with less work) - continuous improvement. One company has an improvement board at the production site where employees can write their ideas that are later discussed during a weekly meeting. Another manager highlighted employees’ awareness of waste in relation to cost and the importance of proper work performance education as important measures that can keep down waste in production. Actually, in this company personnel sorting out bread going to waste had been “too aware”. Bread that was supposed to be thrown away was sometimes sent to retailers anyway. This since personnel thought it was a pity to throw bread that really just had a small flaw, nothing that influenced the quality or safety of the product.

Waste Handling

Bread waste formed during production was sent to farms as animal feed from all three producers. In addition, one of them used parts of the bread waste to yeast production. Companies producing both packed and unpacked bread treat these two types in the same way. The packed bread has to be unpacked before fed to animals; a machine performs this, usually at the farm. It was not totally clear for all respondents how the plastic bags are treated after unwrapped by the machine. One of the companies was planning to change their waste handling in the future. By having a biogas producing facility they can use their bread waste to produce biogas.

Relationship with Retailers

All three producers participating have clients with full rights of return contracts. This means that retailers only pay for the bread they manage to sell and that producers take back what have passed the given date restrictions. In this way the retailers take no financial risk when salesmen place orders. There might be somewhat of a problem for the salesmen; retailers tell them to provide filled shelves at all times and the producers tell them to lower return rates. It was explained that in those cases where salesmen order the bread they have a fixed salary plus provision. If they have return rates above a certain limit, their provision is lowered. In this way it can be said that the salesmen and the producer take the financial responsibility for returned bread together, or the producer does at least make sure the salesmen order responsibly. This "shared responsibility" had just been implemented at one of the companies as a measure to reduce the amount of waste from returns. It was also noted that the next step in this should be to share the risk with retailers as well. This would give them stronger incentives to engage in reducing the waste.

One manager clearly stated that as a producer who is responsible for the bread sent back in return, the company is absolutely not satisfied with retailers having full rights to return products. Some time ago a couple of producers joined to get rid of the full rights of return, but since there were a lot of other bakeries they were forced to take it back in order to be competitive. The relationship between producer and retailer has been like this for a long time. It was pointed out though, that it might be hard to lower waste rate when it doesn't cost anything for the retailers to return unsold bread. Two out of three producers believed that the full rights of return contract have to be revised in order to receive a waste reduction.

The fact that retailers want full shelves at all times and producers at the same time also have to consider the amount of waste formed due to wrong deliveries might create contradictions. Interviews conclude however, that no such contradictions exist. As long as the full rights of return contract exist producers can understand the way retailers think. Producers have to work a lot with refilling and removal of old bread together with statistical analysis on selling rates in order to deliver the right amounts of bread. They want to sell as much bread as possible, and to do that they know they have to keep the shelves well filled.

Waste in Retail

When it comes to bread waste formation two managers stated that the step where most waste is created is in retail (returns), and one thought it is consumers that waste most.

All three companies keep track of sold and returned products from the stores, partly so that they know what they can charge retailers for. Return rates can also be used to make statistics and plan future orders.

Table 11 presents what types of bread the three companies produce, their return rates and for how many days they allow their packed bread to be placed on shelves in the store.

Table 11. Type of bread produced, return rate and the time producers allow packed bread to lie on shelves in stores.

	Company 1	Company 2	Company 3
Bread types produced	Packed and unpacked.	Packed and unpacked.	Packed.
Return rate	17 %	8%	3 %
Time on shelf	2 days after baking day.	2-3 days prior to best before.	2-3 days after baking day.
Shelf life	? "Our bread does not keep for 7 days like other industry produced bread, and we don't want it to either."	5-7 days.	8 days.

Return rates varied a lot between the different companies, from only 3 % at one producer up to 17 % at the one with highest returns. The one with lowest returns produces only packed bread and leaves the bread for two to three days on shelves. The one with highest returns produces both packed and unpacked bread and leaves the packed bread two days on shelves. This manager claimed that there actually is no difference in waste amounts between packed and unpacked bread, most people believe that unpacked bread has a much higher return or waste rate than packed, but that is not the case. Both these companies remove packed bread several days before its best before date. The third actor produces both packed and unpacked bread and has a return rate on 8 %. They allow their packed bread to stay on shelves until two to three days before best before date.

Bread taken back in return is treated like bread waste from production at all three companies, regardless if it is packed or unpacked.

Waste by Consumers

Producers regarded waste by consumers as part of their responsibility. They stated that by producing smaller and tastier bread they might influence consumers to waste less. If there were suitable package sizes for different household sizes consumers might choose, not only what is cheapest, but also consider the environment and the food waste issue. It was also mentioned that in order to change the behavior of consumers the industry could use help from higher levels, like the institute of bread or the National Food Agency.

Producing managers were also asked if they think that consumers consider their own wastage of bread as a problem. One stated that if consumers did consider it an issue they would not throw away that much bread. One reason for consumers not to reflect much is the low price of bread. Another manager agreed in thinking that consumers not consider their waste of bread an issue, anyhow, they might think

more about the environment than the economy. The third interviewee thought that consumers are getting more aware of that they waste a lot. This might partially be a result of more expensive garbage collection and composting which makes the waste more visible than before.

No one of the interviewees knew what consumers state as the main reason for their wastage of bread. They guessed "Too dry", "Passed best before date" and "Not longer fresh" might be the reasons.

Future measures

All three companies have plans and goals set on how much they should reduce their return rates and on what level the waste in production should lie at.

Experts had different thoughts when it comes to how much education of employees would help to reduce the waste in production. One of them thought that personnel already are aware about wasting rates and that extra education in environmental and economic effects would not have any effect on the actual wasting rates. The other expert was more uncertain and thought it might help to educate personnel but employees should be aware of the food waste issue by now. Especially with all the attention the food waste problematic has received in media lately. The third manager however, thought extra education might help to increase knowledge and understanding among the employees.

4.1.5 Bread Waste – Discussion

Formation of Bread Waste in Production

The fact that producers keep track of all wasted bread is probably valid in all producing companies since losses affect the profitability. Furthermore, they also have to keep track of that sufficiently large amounts are produced to cover orders. This requires them to know how much that might be wasted during production. 1-2.5 % waste is not much; especially not in some cases when compared to amounts wasted due to returns from stores, see 4.1.4 Bread Waste – Results, subheading "Waste in retail".

It seems like a lot of different things can go wrong during production, bread is a "living" product and can be affected by a lot of external factors. Reasons for waste creation during production mentioned in interviews were really similar to those explained by Karlsvärd *et al.* (2008). Further, as was described by Söderlund (2007), overproduction due to unforeseeable losses in production and to assure delivery of ordered amounts also showed in this study to create waste. It seems like some amount of waste that is formed, due to overproduction, is bread that is perfectly fine to be sold in stores. Instead, when all ordered bread is delivered, the excess bread is wasted. This feels like a real and unnecessary waste of resources. It would be interesting to investigate if something else can be done with this bread. For example it might be possible to give the bread to charity, give it to employees at the company or sell it to a reduced price in a bread factory outlet.

Difference Between Packed and Unpacked Bread

On beforehand one could imagine that there is a difference in waste amount during production between packed and unpacked bread. The packaging itself renders in one extra step that can result in waste formation. In addition, packed bread is often sliced and this demands one further step where something might fail. On the other hand, the packaging can protect the bread from contamination in the air and from human contact - this is lost when the bread is unpacked. To summarize, receiving this information was kind of crucial. Since no big difference can be seen in waste amounts between packed and unpacked bread waste it suggests that the packaging in itself does neither increase nor reduce the amount of bread waste during production.

Producers Interest in Reducing Waste

Once again it comes to companies wanting to reduce their losses as much as possible since it costs money and influence their profitability. Maybe only one of them admitted considering bread waste an issue since it might sound worrying for a company to have a problem with waste formation in production. Especially since waste is connected to something "bad". However, all seemed to care and work to keep it as low as possible – some good things do come out of producers wanting to be as cost-efficient as possible.

Prevention of Bread Waste Formation in Production

As mentioned in the previous paragraph, it seems like producers care and make efforts in order to keep the waste as low as possible. This might be the truth, at least as long as the effort doesn't cost more than to produce and handle bread going to waste. In the end, it seems to be all about the money. No one mentioned the environmental effects of wasting bread here; this might mean that they care more about their economy than the environment. Not saying they don't care about the environment at all but it would not be strange if personnel working at a producing company considered money in front of the environment. Further, many of the measures taken include the behavior of personnel that work on the floor in the bread factory. Since human factors was said to often cause errors in production this is probably the right area to focus on.

Waste Handling

It seems like a standard measure to send bread waste from production to farms as animal feed. This result conflicts with a report by Norden (2011), where it was stated that it costs more to empty packages and send as animal feed than to incinerate both. Packed and unpacked bread are treated with the same methods, it is probably easiest this way. If they have found one method that they are satisfied with, it is only reasonable that they apply the same method on both types of bread. The packaging demands one extra step in the waste treatment, but since the unwrapping is performed by a machine on the farm one can imagine that it might not require that much work from the farmer. And it forms however no extra work for the producers. What then happens to the packaging was not totally clear for all three managers. Maybe someone else at the company has more insight in this.

Otherwise, when the unwrapping takes place at the farmers the packaging waste responsibility might have passed away from the producer.

It is an advantage that the bread is prevented from bad waste handling methods like going to landfill. In addition, it seems to be possible to come up with a solution together with farmers near the production site. This local collaboration means less transportation between the factory and the final waste destination. It would be interesting to find out if the farmers pay for the bread or if they pay by taking care of the waste and maybe pay the transportation costs to the farm. If the bread is one of the main feed sources the farmers might be willing to pay a lot to make sure it is provided. This might mean bread-producers can make money from the waste and this could explain why this method is preferred in front of sending the waste to incineration or charity (when it comes to the handling of bread that is perfectly fine for consumption).

Relationship With Retailers

Through making salesmen who order bread financially affected when returning high levels of bread, producers make sure that the salesmen order responsibly. This seems like a really important measure in order to make ordering more accurate. In this way prevention of excess waste formation can be accomplished. If this was not the case, sellers might bring as much bread as possible to fill shelves every day since they wouldn't lose on taking large shares of bread back in return – only earn money an all products that are sold. Further, it seems important that there is a limit also when retailers themselves order bread. It is unclear though exactly where this limit goes and thus to what degree retailers really share the risk with producers.

It was interesting that some producers tried to get rid of the full rights of return contract but failed since there were others willing to offer this service. It is kind of obvious that this kind of agreement is advantageous for retailers. Thus, it is understandable that producers might be unsatisfied with the contract. In one way it is strange that the contract in so common in the bread sector when the trade of a lot of other perishables are not under this contract.

Waste in Retail

The expert who stated that consumers waste more than retail works at the company that has the lowest return rate among the three participating companies. Thus it is not strange that she perceives that consumers waste more than retail – and it might also be the truth. As has been described in literature before, in developed countries retail and consumers have been pointed out as the main source of food wastage (FAO, 2011; Parfitt *et al.*, 2010). It seems to be this way in the bread sector in Sweden too. For each step that is added in the FSC before a food gets wasted, the more resources are wasted with the food. As was pointed out by Eriksson and Strid (2011), this makes it possible to regard reduction of waste in the end of the FSC even more important.

There is a great difference in returns between the companies. This might partly be explained by the time bread is allowed to lie on shelves before it should be returned. This has to do with a certain image and feeling that the company is trying to create.

However, the one with real high return rates only remove their bread one day before or at the same day as the one producing only packed bread, having the lowest returns. The fact that the company with lowest returns rates only produce packed bread implies that the unpacked bread might contribute with a large part to the returns. The manager with highest return rates, producing both packed and unpacked bread, denied this. Thus, it is hard to tell how the time on shelves affects the return rates. Maybe it is more a question of placing correct orders. It would be interesting to find out if there is any specific time after baking day when consumers no longer purchase bread. Then it would not be needed to keep bread on shelves for longer than that. Or on the opposite – if baking day is that important – it might be appropriate to revise the existence of this date label since it could be a large contributor to waste formation.

Waste by Consumers

It is a good thing that producers consider themselves partly responsible for waste created at the consumer level. The question is, as they stated themselves, how much they really can do about it – except from providing consumers with products they want. If consumers are satisfied they probably waste less than if they are not. It might be possible for producers to send some messages on the packaging, which might indirectly affect the amount of waste by consumers. For example, information on how to use the bread if it has gotten dry (e.g. recipes), or that you should avoid throwing away bread could easily be printed on the packaging. Producers did also come up with more direct manners in relation to the packaging that might affect the amount of bread consumers throw away, for example to provide packaging sizes suitable for all household sizes. Thus, they were a bit contradictive since all of them stated later that the packaging could not be related to any degree with wastage of bread.

It might be true as one manager stated that bread is too cheap for consumers to care about their wastage. Thus, it might be really important for consumers to actually see the food they waste to make them more aware of the problem. As Karlsvärd *et al.* (2008) and Fredriksen *et al*. (2010) describe, a lot of bread thrown away today can be found in its original packaging. The ongoing implementation of food waste separation in Swedish communities might thus help reducing the amount of waste simply by making consumers see how much food they throw away. This would also require them to take the bread out of the bag and this could also make them realize how much they really waste. In addition, a price increase on waste handling services might force people to get more restrictive when throwing away food. By making active choices of what to throw away their habits might change. It is probably important though that this waste handling doesn't cost too much either, in that case people might not buy the service and the whole point of separating food waste might not be accomplished. To make sure people separate waste the fee for the mixed waste bin should always be most expensive. Malmö is a good example, since January 1st 2013 houses can get their separated food waste collected for free (VA SYD, 2013).

It was really interesting that producing managers didn't know what consumers state as the main reason for throwing away bread. It is possible that someone else at the

companies have this kind of information, but beforehand it was thought that most people at a bread-producing company should know this.

Future Measures

It was not surprising to find out that all companies have goals on reductions of waste and return levels. If they manage to reduce waste, and retain the same price on their products, they will make more money. In addition to this it would be possible to reach out to consumers with the message of having low waste rates and form an environmental friendly image that the company might gain further from.

Naturvårdsverket (2008) proposed that informing personnel in production about the environmental impact of food waste might be a possibility to reduce waste in the food industry. Bread producers were a bit uncertain what effects such measures might have. Anyway, since none of them had facts that this measure wouldn't work it can absolutely be worth a try.

Those who thought a reduction of waste demands the retailers to get some sort of economic incentive are people working at companies with highest return rates of the three participants. The one with lowest return rate did not mention this as a problem. One can wonder how this company manages to keep return rates that low compared to other actors. Is it possible that they are so much better than their competitors on estimating sales and deliver right amount of bread to the stores? Or does it have to do with the fact that they only produce packed bread, even though producers of both types claims there is no difference in waste formation. It does seem like there might be something in addition to ordering systems that creates this large difference in returns. It might have something to do with how stable the two markets are. If the market for packed bread is more stable it is probably easier to predict sales and orders. It would be really interesting to find out if this is the case or if not - what forms this big difference? However, it might not be that easy since the company with low returns probably have worked hard to come to this point and might not want to share what has made them succeed.

4.1.6 Packaging – Results

Current Packaging Systems

Experts at producing companies described the packaging systems that are used today. Packed bread is usually packed in some sort of plastic bag sealed with a plastic clip with metal or a quick lock. The plastic material of the bag depends on what purpose and feeling the producer want to create. Polypropylene (PP) is clearer, more rustling and can allow for more bread to be visible. Polyethylene (PE) is milkier and can be used on basic product ranges, to be more traditional and look like it did in the past. Bread sold without packaging can be placed straight into secondary packages, or packed in a large plastic bag, or with paper in the bottom of the secondary packaging and on top to allow circulation of air and maintenance of crust. As secondary packages stackable boxes are used. Two companies use boxes in hard plastics, these are taken in return, washed and can be re-used many times. The

third company uses boxes in corrugated board made from 80 % recycled fibers and these are recycled after use.

Reasons for Having Current Packaging Systems

Employees at companies using plastic crates as secondary packaging stated paper would be too expensive – when you have used a plastic crate twelve to 13 times you earn on using plastic instead of paper. In addition, one of them stated that paper crates would not be in line with their environmental profile. On the other hand, the company using corrugated board boxes also stated they use them with the environment and economics in mind. They have not managed to find a plan that is sufficient cost-effective to implement plastic boxes that can be used several times. In addition, there is a hygienic aspect that must be taken in mind when it comes to re-using packaging in the food business.

Interviews showed that plastic bags are used in order to keep the bread soft, to enable transportation and durability when it comes to hygiene. Connections to previous use, it has been like this for a long time, was also used as an explanation for having current packaging systems. Unpacked bread is packed in paper bags in retail stores to keep the crust – plastics would not let it breathe. With material choice and packaging design a special feeling of different kinds of bread can be created.

Dialogue with Packaging Supplier

Experts from bread-producing companies were asked what kind of input they can get from packaging suppliers when it comes to the choice of packages for bread. It was made clear that the bread producers are in charge of, and at the same time responsible for, that the packaging is suitable for their products. The packaging supplier are then demanded by bread producers to deliver packages that are safe and approved to be used in contact with food. Suppliers do however not guarentee anything that has to do with the quality of the bread, like keeping qualities etc. It was somewhat uncertain whether suppliers have any special knowledge in the field of bread. One manager stated that suppliers have no knowledge in the field of bread, that they only sell their packages – not the product it contains when reaching consumers. The manager claimed he would like packaging suppliers to work more to sell the whole bread-packaging concept.

Packaging Design

According to interviews, bread-producing companies decide the design and make a technical specification of the packaging that is then sent to the packaging supplier. It varied between the companies whom and how many people they involve in developing a packaging for a certain bread product. At one company the development manager had pretty much the whole responsibility and at another company staff from several departments like marketing, design, purchase and sales were included in the work. The retailers themselves design packages for private label products. Today work is put mainly into refreshing the design or change material of existing packages in order to create a new feeling, or development of new packaging. This development includes graphical design as well as optimization.

It seems like most efforts are put into work with new products rather than on optimizing existing packaging.

Alternative Packaging Designs

When asked whether there are a lot of packaging options to choose from, two managers answered "no". They concluded that there are "green" bags made from corn and sugar cane but at this point they are too expensive and not worth it. There are also thicker plastics and bags that can be resealed with a perforated mechanism, but this might destroy the handmade feeling some producers are seeking to establish. The third expert, the one working as packaging purchase manager, stated that there are options, depending on what kind of packaging machinery you have installed. In addition to earlier designs there are for example paper bags, boxes and "flow pack". Here a machine creates a bag by melting two pieces of plastic film together. A piece of bread is placed in between the pieces before they are fused into a bag.

Two producers hadn't really tried out any other packaging systems than those that they currently use, they had experimented but not applied anything. The third company tried out using paper bags coated with PE on the inside to keep the bread soft. This resulted in more expensive packaging and thus more expensive bread and was therefore not used further.

Date Labeling System

All producers label their bread products with both baking day and best before date, one of them having their bread also marked with what day of week the bread was baked. This was thought of as an extra feature that consumers appreciate. One manager stated that it is really enough with best before date but consumers, and customers like retailers, want to have baking day as well. One of the others agreed that consumers see baking day as the most important date label on bread. Another manager claimed on the opposite that consumers want to have best before date these days; it has shifted from baking day being most important before. Nowadays consumers are focused on for how long it will be possible to eat the bread.

It was made clear that not all producers are satisfied with the date labeling systems used today since they might create more waste than necessary, both in retail and households. More or less all producers do however use the same system since consumers are said demanding it to include both best before and baking day. Removal of baking day might however have the possibility to result in a reduction of the amount of wasted bread. This since consumers use the baking date label to choose only the freshest bread. Thus bread that can be consumed for several days further but baked more than one-two days ago are left on shelves and sent in return.

Managers at bread-producing companies were also asked what they think about a labeling with "at least preservable until" instead of best before. Two of them didn't think a change would matter, since they were of the opinion that baking day is the most important date label. The third thought "at lest preservable until" might also work, but that it is really the same thing as best before. Today bread is marked with best before but it is also possible to eat after this specific date.

Main Functions of Packaging

Main functions of the packaging mentioned during interviews were as follows; to protect the bread and keep its hygiene, to reinforce the value of the product and provide a certain feeling, to keep the bread for a certain amount of time and to make the bread visible.

Packaging Role in Prevention of Bread Waste

None of the experts from bread-producing companies thought that the amount of bread wasted is related to the packaging. The plastic packaging used today was said to make people waste less bread than if for example a paper bag would have been applied instead.

When thinking about the possibility of another packaging than that used today to prevent more waste no one could come up with a suggestion of how this could look. Maybe if the bags were larger the bread would always fit and problems in the packaging machine would be reduced. This would however make the packaging less appealing and can also be regarded unnecessary packaging material. This issue was however something the respondents were well aware of. It was mentioned that in the past, focus has been on the packaging – and to reduce the amount of material. Nowadays the focus has shifted to the problem of food waste and the bread producers are trying to adapt to this. Among other things they produce packages in varying sizes in an attempt to provide products suiting different household sizes.

Consumers' Packaging Demands

Having a communication with consumers about their opinions regarding bread packaging can be hard for smaller companies. It is common for companies to have consumer contact but they often get more input on the bread itself than on the packaging. It was said that a better communication could improve the packaging, and that this dialog absolutely could end up in a change of packaging performance if sufficient amounts of consumers have the same opinion. Producing companies, no matter of what size, receive trend reports on the matter from other actors like sellers, suppliers and the institute of bread.

Producers did however not think it is hard to communicate with consumers due to the distance producer – consumer. Thanks to the daily contact between salesmen and customers as well as consumers in stores the relationship with consumers feels rather close.

Producers were asked if a packaging change, as a result of consumer demands, like another date labeling system or varying packaging sizes would be a problem for them. In general this was not seen as a problem but it was mentioned that the packaging size affects the "face" a product get on a shelf in the store. A small product gets a smaller face, meaning much less commercial and market shares than large bread. Thus, small bread might be outcompeted by products sold in larger packages after a while. A larger packaging can provide more advertising at the same time as

the shelf look full, which usually satisfies the retailer. This has to be considered if smaller products are put on the market.

Smaller Packaging to Reduce Waste

Experts were not totally in consensus when it came to the possibility of smaller packaging sizes to reduce the amount of waste by consumers. This topic was discussed having in mind that the number of single households tends to increase in number in Sweden. Some producers thought they already provide a varying range of packaging sizes. One of the producers tried to produce some smaller breads a couple a years ago but they didn't sell. It was further discussed that this might work better in larger cities, assuming the frequency of single households is larger here. Another manager was kind of sure that smaller bread would help reducing waste but had not tried to include smaller bread in the assortment.

It was however mentioned that the trend does not go towards larger packaging and that the request for alternative packaging is increasing. This as a result of changed lifestyle and consuming habits into a society where "grab and go" is more requested. In the end it was once again mentioned that when consumers are unsatisfied with the size, they could split the bread and store some parts in the freezer. This measure was however not mentioned in the interview with the expert from the company having freshness as one of their main selling arguments.

Future Packaging Systems

Interviews showed that plastic bags probably will remain as the basic packaging solution even in the future. It is a question of what consumers are willing to pay for. If they demand something else it would be profitable to change the design. Some innovative solutions will probably appear, maybe solutions that are more "all set" like bread and butter in the same packaging. Two out of three interviewees mentioned that smaller packages might have a future. It is further possible, or maybe more kind of a wish, that it will be ok to run out of bread on shelves or that the delivery of right amounts can be adjusted with deliveries several times a day.

4.1.7 Packaging – Discussion

Current Packaging Systems

The three producers use very similar systems when it comes to the primary packaging. These systems were also described by Wallman and Nilsson (2011). It seems like different plastic materials are chosen mostly to create a certain feeling of a product – not to provide different properties that has impact on the durability or quality of the bread. None of the producers use packages that stand out from the rest.

When it comes to the secondary packaging there seems to be two basic systems used – boxes in either hard plastics or corrugated board. It is understandable that it might be difficult, and a real extensive work, to change the current system from for example corrugated board to plastics - especially in a large company. On the other

hand, there are greater possibilities to make a change that actually means something for the environment in a larger company.

Reasons for Having Current Packaging Systems

Both companies using plastic boxes and corrugated board boxes claim they do so of environmental reasons. This makes it hard to judge whom of them that are right - if there really is one system out of these two that actually is more beneficial for the environment than the other. One further question is how many times a plastic box can be re-used? And how many times does it have to be re-used to be better for the environment than boxes of paper fibers? Can a box made of a material that is not renewable ever be more environmental friendly than one made from a material that is? These kinds of questions have to be considered when trying to find out what system is favorable from an environmental point of view. In addition, the weight of the secondary packaging should also be considered. A heavier box requires more energy to be transported. Further, empty boxes that not have the possibility to be flattened during transport take up much space and have lower transport efficiency than boxes that can be flattened. Life-cycle assessment might be a helpful tool for companies to find out what system that is best for their products from an environmental perspective. This method includes environmental impacts from all phases of a products life – from cradle to grave. There might not be an absolute truth on this question – the answer might depend on the situation. It might be that one system is better for short distances between bakeries and shops and another over long distances.

Packaging Design

Larger companies seem to involve a lot more people when developing a packaging than smaller ones. It is not strange since smaller companies probably have a smaller budget to use on these kinds of things. One can wonder though, how much better does the packaging at a larger company, where a lot of peoples' opinions have been considered, get compared to that designed by only one person?

Alternative Packaging Designs

To summarize, experts gave the impression that there are not many alternative packaging designs to choose from, more than those used today. When a new packaging is developed today it mostly concerns creating a new design or choosing a material to reinforce a certain feeling. This is probably the way of thinking in any business until a new invention is made. It is hard to imagine things that don't yet exist.

Dialogue with Packaging Supplier

Packaging producers probably supply many different sectors with packaging, both areas in the food industry and those in other branches. Their awareness of the legislation regarding safety and material contact with food seems like the most important demand from the bread producers. If materials used not are allowed in contact with food that could result in extensive consequences connected to safety and have huge effects on image and trustworthiness of a company. Not just the

company producing the packaging but also its clients – the food producers. Thus, it feels fair that the packaging suppliers reassures their products are safe and approved to use with food, then it is up to bread producers to choose exactly what material etc. they would like for certain products. It might be desirable though, for the two parties to work a bit closer in order to come up with new packaging designs that can help in reducing the amount of waste.

Date Labelling System

Managers didn't agree on which date label that is most important for consumers – baking day or best before date. Two of them thought baking day is most important, the third stated it has shifted and now best before is most important. It might be possible that the first two not were aware of this change if it has shifted recently. It would be good though for the whole industry to keep track of consumers' demands in order to fulfill them, especially if one of their previous demands is connected with forming waste and it now can be removed. Thus, it would be interesting to ask consumers if they are more interested in one or another of the two date labels in future work. Today legislation state that it is mandatory for producers to mark bread with best before date but baking day is optional (Livsmedelsverket, 2007). Thus baking day could be removed if consumers no longer have the interest in knowing which day the bread was produced. Although at this point it has become somewhat of an unwritten rule to add baking day on the label as well. If one actor removed the baking day consumers might choose to buy another product with date just to be sure that it is fresh. So, as long producers think, or know, consumers care about baking day they will probably not take the risks included in being first in the market without baking day on the label. The baking day is after all a way for producers to show consumers their products are fresh. Thus, an industry agreement to stop adding baking day on the label would be needed.

It can be discussed how important baking day on packed bread really is since consumers buy unpacked bread all the time - without date labels. Consumers probably expect the unpacked bread to be fresh, produced the same day; this might not always be the truth. If unpacked bread had a date label it might affect the amount of waste created if bread older than one day are sold today. The date label would then help consumers make sure they don't buy bread older than one day if that is what they want.

Maybe, consumers' interpretation of date labels is more important to focus on than the choice of what system that should be applied. The majority of consumers did however in a study by WRAP (2011) claim that they feel very or fairly sure they understand the meaning of date labels on food. This is however no assurance that they actually do so.

Further, another study pointed out, from reviewed literature, that date labels are particularly important for consumers while in the store making purchases (WRAP, 2011). Further, the same study highlighted that bread is among those products that consumers felt particularly important to check the date on in-store. This since they had a preference for bread to be as fresh as possible at the purchase. This implies that consumers still might consider baking day as an important label when buying

bread. The study was performed in Britain – so there might be a difference among Swedish consumers. Further, a large fraction of bread waste seems to appear in the stores as unsold bread, and previous studies show that a lot of people care about the date labeling, especially when in the store. This suggests that removing the baking day from the label could reduce the amount of waste formed in stores since consumers might buy bread that they wouldn't if baking date was applied. As was discussed above, a decision covering the whole bread industry might have to be taken in order for all parties to remove baking day. Another possibility could be to keep baking day and instead use different prices on bread, depending on how far from baking day they are. "Older" bread gets cheaper than "fresher" bread. This might be hard to implement as long as retailers have full rights of return, as today no one reduce the price on bread closing up on its best before date. A decision covering the whole bread industry might as well have to be taken in order for all parties to reduce prices on "older" bread.

A report by the Consumer Association of Stockholm (2009) suggests that it might be better to apply a system with "at least preservable until" instead of best before. This since a majority of respondents in their survey claimed they would prefer this kind of label. Interviews with packaging mangers in this study did however show that they not had any stronger believe in another system to reduce the amount of wasted bread. Mainly since they believe baking day is the most important date label. Studies like the one by WRAP (2009) show that when at home, consumers use the date labels while judging whether to throw away a food or not. 29 % said the most common reason for them to throw away bread was that it had passed its best before date. Thus, it is really important that they understand the meaning of the label. Just because bread has passed it's best before date it does not mean it is no longer appropriate or "safe" to consume. Thus, it might be possible to influence the formation of bread waste in households with another date labeling system or more clear explanation of the existing system.

Main Functions of Packaging

When describing main functions of the bread packaging all aspects that were mentioned during interviews were related to the two matters of protection and communication. No one mentioned functions related to containment, apportionment, unitization or convenience, as was described by Lockamy (1995) as additional important food packaging functions. A loaf of bread doesn't really need to be contained or apportioned like e.g. a fluid does. Further, a loaf of bread is really already one unit and the convenience can be related more to the slicing of the bread than to the packaging. Thus, it was not strange for these aspects to be regarded less important than protection and communication by the packaging managers.

Packaging Role in Prevention of Bread Waste

It was mentioned during interviews that concerning the environmental impact of food-packaging systems the focus has changed regarding what is seen as the most important aspect. Focus has shifted from the packaging material type and amount to the importance of formation of food waste. This is exactly what Svanes *et al.* (2010) described. It is positive that this was brought up during interviews, suggesting that the message have been received at some companies at least.

No one of the experts thought bread waste can be related to the packaging when asked directly to what the degree these two can be connected. Yet, all of them suggested different matters that concern the packaging, like removal of baking day and importance of packaging sizes to provide all consumers with suitable sizes, to reduce waste. Maybe they thought of aspects like the packaging material when considering this connection, even if the interviewer did remind them of date label, size and information on the packaging while discussing. However, these answers were a bit contradictive. It might be due to that managers consider the packaging used today as the best one at this point in reducing waste. This does however still mean that it is possible for a better packaging to be developed in the future. Further, if the packaging has a defect it is probable that producers themselves, retailers or consumers reject the whole product. Meaning if the packaging doesn't fulfill basic expectations it might be the reason that the product it is holding goes to waste.

Consumers' Packaging Demands

It seems important for producers to keep track of consumers' demands since they are the ones steering the market. If something makes consumers unsatisfied with a product there is probably a risk that consumers might end up throwing the bread away. The packaging can be thought to have a crucial role, since it mediates a certain feeling and have impact on consumers' impression of a product. If some of the must-be attributes described in Kano's Theory of Attractive Quality and Packaging, by Löfgren and Witell (2005), are not fulfilled the risk of having unsatisfied consumers is evident. Unsatisfied consumers would have an even larger impact on small companies. Thus it seems crucial for smaller actors to have the possibility of receiving information related to trends etc. from other instances. This is especially important if they don't have resources to perform these kinds of surveys by their own. In the end, this co-operation in the bread industry might have a huge power to affect the amount of waste that is formed. It might need competitors along the FSC to co-operate with regard to waste reduction, as it seems like some of the waste is created due to the normal competitive market mechanism.

Producers did not agree with Karlsvärd *et al.* (2008), that the distance between them and end consumers are a problem making it hard for producers to realize what requests consumers have regarding packaging and new products. It is kind of special though in the bread industry compared to other food areas. The full rights of return contract brings salesmen out to retailers every day and creates a kind of special and close relationship also with consumers in the stores. It can be questioned though how much of a dialog that is carried out directly between consumers and salesmen. Consumers might express their opinions to retailers who then can pass this information on to the producers.

The issue with smaller packages getting less commercial and market shares than larger ones can probably be compensated for if retailers are aware of why smaller packages are being produced. You might just put up more small packages on the shelf - the problem here though being that you might not want to have more packages on the shelf since you know you only sell a certain amount. By designing the bread department in a way that small packages do not "disappear" among larger

ones this could be avoided. As with everything, to reduce the amount of bread wasted in the whole supply chain, it is needed that all parties are aware of the problem and are willing to co-operate to get a result. Even if that might, to start with, be measures that some of the parties are not totally satisfied with.

Smaller Packaging to Reduce Waste

Interviewees were not totally of the same opinion when it came to smaller packages' ability to reduce waste. It did however seem like all of them saw some kind of possibility for this to make a change. This is, as mentioned before, another example of contradictive answers in interviews, since all managers stated that the waste could not be related to the packaging to any degree. Thus, it might be as described by both Karlsvärd *et al.* (2008) and Fredriksen *et al.* (2010) that an increased availability of smaller portion packages, as the number of smaller households has increased lately, can be a future measure to reduce waste formation. Further, smaller packages might not only be useful for single households. It would also allow for more flexibility in big households – they could buy two small packages instead of one big and get two different bread types. They could also use the smaller packages as a complement to large ones – buy one large and one small to be sure they have time to finish it in time. The problem in general with these smaller packages might be that it probably will have a higher price than large packages – at least when it comes to price per weight. This might make people choose packages from which they get more bread for their money. This even though they state on beforehand that they would like to have more varied packaging sizes to choose from.

The option to deliver more often to each store in order to adapt to variations in consumption results in increased transportation cost and impact on the environment. These factors have to be included when a calculation of the total impact and cost of the deliveries is performed.

Future Packaging Systems

It is always hard to imagining things that doesn't exist yet and when they later have been invented one can feel stupid not to have thought about it before. Consumption trends and lifestyles of people in general do probably affect consumers' demands on bread as well. It seems possible to utilize these things to develop new packaging. It doesn't seem like the basic packaging design will change that much since all parties are satisfied with its capabilities. Maybe if there was a change going on it would not been revealed in interviews anyway. It seems though development might be more a question of concepts, concerning both the packaging and the product inside. It might be possible to buy several kinds of bread in the same packaging or bread and butter in a ready-to-go package in the near future.

Deliveries several times a day would mean extra transportation and might reduce transport-efficiencies and require extra fuel. It might be possible for salesmen to deliver smaller amounts of bread and target more shops in one load instead, to compensate for additional transports. In that case direct information concerning the store supply of bread could be utilized to deliver bread one more time later in the day. A calculation of which alternative that has the lowest negative impact on the environment will have to be performed before it can be concluded whether two, or several, deliveries a day can be preferable and if it has the ability to reduce the

amount of returned bread. It might be some days when it is extra hard to predict sales, like holidays and then an extra delivery could be used to compensate for the large sales variations.

4.1.8 Finish – Results

To close the interview, experts were asked to summarize what they consider as the main issue, through the whole supply chain of bread, creating bread waste.
Problems mentioned by each expert were the following:

- Estimation of sales rates and delivery of right amounts of bread to the stores.
- Full rights of return and date labeling system.
- Full rights of return since most waste appears in retail stores.

One producer, who did not receive information from retailers cashier systems, wanted to improve the knowledge of the market in order to deliver right amounts in the future. In this way they could reduce their high return rate and the amounts of waste. To have insight into retailers cashier system would help in predicting sales.

4.1.9 Finish – Discussion

In order to solve some of these problems it might be required to make retailers aware of the high return rates some companies have. It might also help to revise the contract while having in mind the joint ambition to reduce the amount of waste. This means there has to be an overall ambition to reduce the waste. It is hard to come up with an idea how this can be accomplished in a world driven by the will to earn as much money as possible. It might require the retailers to get financially affected by returned bread in order to make them engage in the waste formation issue in some way. Further, development of new systems for ordering, that includes information from cashier systems, might help to place more exact orders. The cashier systems should be available for all producers in order to reach the joint ambition. Further it might be valuable to continue the discussion regarding what date labeling systems that are appropriate to apply – also taking the waste formation into account.

4.1.10 Summary – Producers

The bread packaging itself can cause waste in production but packed bread is not wasted to a higher degree than unpacked at this stage. Interviews revealed that there is often relative little formation of bread waste in production compared to other steps in the FSC. Retail and consumers waste a lot more and this suggests that actions also have more to gain from reducing waste at these steps - especially since the waste of resources increase along with steps further in the FSC. The producing industry does however have the possibility to affect waste formation in later steps. This can be done through for example development of suitable packages and a co-operation with retailers when placing orders. When producing bread one of the main issues is to know how much bread that is appropriate to produce. Statistics on return rates and previous sales rates can be used to predict correct orders. Producers can sometimes receive information from retailers cashier systems. Producers receiving this information have much lower returns than the producer who doesn't – suggesting this information might be crucial to keep down waste

rates. Further, interviews showed that it is common for salesmen at the producing companies to place orders on bread for retail stores they deliver to. This seems to be the consequence of the full rights of return contract, applied between most producers and retailers. The contract allows retailers to return unsold bread to the producers without being charged for it, and, not surprisingly, all producers are unsatisfied with this agreement. It seems however hard to compete with other producers without offering this contract. Estimation of future sales is difficult, regardless of who has to do predictions and a better co-operation between retailers and producers might be needed to develop more precise forecasting methods.

Interviewed packaging experts did not know what consumers state as the main reason for them to throw away bread. Further, a better dialog might have the possibility to improve packaging in a way that consumers want them to be. It seems possible that smaller packages can help provide different household sizes with suitable bread and in this way help reducing the amount of waste. The date label system affects consumers' behavior and might need further evaluation to have a proper design that can be interpreted by consumers in a desirable manner.

It can be concluded that consumers rule the market and producers do what they can to fulfill must-be attributes and make consumers satisfied. Furthermore, the bread industry is a normal competitive market and companies try to make money – as much as possible. The market driven approach might not always go hand in hand with the struggle to reduce waste. This might prevent the necessary co-operation between different actors on the market that might be needed in order to form a joint work towards reducing the amount of wasted bread.

4.2 Expert Interviews – Retail

4.2.1 Introduction

Interviews with managers of retail stores or bread departments in retail stores were performed during personal meetings in three different stores. The interview plan used during retail interviews is presented in Appendix 2 – Retail interview. Following sections present results from the interviews divided into sections in the same way as the interview was. The same kind of structure, as the one used in producer interviews, was applied here – with some sections removed and others included. After result presentation, a discussion and comparison with other literature follows in a separate section, using the same subheadings as the result part. In the end of chapter 4.2 a summary describes the main findings from the retail interviews

Since interviews were carried out in personal meetings the information handled during the conversation might have been affected by how the interviewer and the respondent interacted. Difference in age and the fact that the interviewer was a young female student with no experience in the field might have affected what kind of information the managers choose to share. Some information might have gone lost because the interviewees presumed certain information was common knowledge. It was assumed though; that shared information was more extensive

since participants knew information was going to be published anonymous than if this would not have been the case.

4.2.2 Retailing Bread – Results

To begin with, the relation retailer-producer in the bread industry has to be explained. From these interviews it can be concluded that producers have employees who deliver their bread to retail stores. These drivers also work as salesmen. They are responsible for delivering a certain ordered amount of bread to stores in their area, and they do this almost every day. Orders are placed either by the salesmen or retailers themselves, this is something the two parties agree on together. It can vary between and within stores which approach that is applied. In this way a close relationship is formed, at least between the salesman and the retailer taking care of the bread department. Salesmen are in addition to this usually responsible for bringing the bread into the store and up on shelves. Later during the day personnel in retail stores can assist producers by refilling shelves and moving bread in front of shelves. In general though, the bread department can be seen as more of a shelf-compartment that is rented by producers to sell their products. Retailers were very satisfied with how this agreement works. Managers from all three stores described this relationship as well functioning and close, and there was nothing that they would like to change.

Ordering of Bread

When it comes to the ordering of bread, retailers themselves order bread that they produce and bake-off bread. Bread produced by other actors, and sold at the bread department in stores, is usually ordered by salesmen at the different producing companies, otherwise by the stores themselves. Interviews showed that retailers think salesmen often are the ones with deepest knowledge of sales in their particular districts and thus, they are best suited to make these order decisions. The salesmen can, and should preferably, have a dialogue with people working in the store and if there are any disagreement the retailer's word is due. Interviews showed that higher levels at the retailer chain often control the bread assortment distributed in their store.

Full Rights of Return Contracts

When retailers buy products from bread-producing companies there are of course some contracts outlining the details in this trading. According to interviews, contracts controlling trade between retail stores and producers can vary depending on what producer and retailer it concerns. In this contract however, there is a fundamental agreement concerning return of products. All retail stores in the study have full rights of return up to a certain limit, which can be specified to a certain percentage of sales. The full rights of return mean producers take financial responsibility for unsold products that are taken back in return. Retail managers state that the full right to return contract has existed for a real long time. It is applied mainly on bread but also to some extent on other perishables like flowers and salads. Retailers are very satisfied to have this contract on bread.

Reasons for Full Rights of Return Contracts

Retailers claimed this is the only contract possible as long as producers themselves are allowed to decide about the amount of bread delivered to each shop. One further reason mentioned for having the full rights of return contract was that if it didn't exist, retailers would be the ones placing orders and then they might feel scared to order too much bread. With the contract this can be avoided. If they would feel scared to order bread their solution might be to produce more of their own bread instead of buying from suppliers. One retailer claimed the full rights of return contract to be an opportunity for producers to sell as much bread as possible.

Full Rights of Return and Bread Waste

Further, retailers had a hard time imagining how the amount of bread taken back in return would change if there was no full rights of return contract. One voice suggested that this would result in lower return rates, and sales. Retailers were consistent in thinking that the price on bread would decrease if this contract didn't exist. This was explained by that all bread wasted today is included in the cost calculations of the producing companies. To compensate for losses due to waste a higher price have to be charged on the bread that is sold. In this way consumers buying bread also pay for bread that is wasted. Anyhow, if the contract didn't exist retailers would be in charge of ordering the bread by themselves. They thought this might, as mentioned before, rearrange their approach to produce more of their own bread or bake-off. This kind of bread can be bought into the store to a much lower price than other bread, and thus wastage of this bread would mean a lower economical loss. Additionally, bake-off bread is stored in the freezer – thus, accurate orders to minimize waste in the way needed for regular bread and other perishables are not necessary. Another approach mentioned was that retailers might reduce their assortment with one supplier in order to increase sales on the others. A narrower assortment was thought to help in keeping down the amount of bread going to waste.

How Producers can Reduce Return Rates

At this point, having full rights of return contracts, retailers had some ideas of how producers might reduce their return rates and thus the amount of waste. Reduction of assortment and more careful ordering primarily caught attention in the interviews. Through being more aware of the current situation; sales rates according to day, week, season, weather, payday etc. and through having a dialogue with personnel in the store, retailers believe this could be possible. Retailers also declared that producers do receive some statistics from retailers cashier systems, but the amount shared varies among retail stores.

Impact of Order Size

All retailers said they have the possibility to order small amounts of bread. This was said to often be the trick in order for retailers to have appropriate amounts of bread in the store (even though they not actually make the orders, but that the salesman who do can order small amounts).

4.2.3 Retailing Bread – Discussion

Ordering of Bread

As interviews showed, salesmen usually order the bread but sometimes retailers assist or have the entire responsibility for this. In those cases it might be preferable if retailers had more to lose on high return rates, this would probably make them prioritize assisting in ordering or be place more accurate and well-planned orders. Today there is a limit for returns, above which retailers have to share the cost with producers, in many contracts. This does however not seem to be enough for retailers to care as much as they probably would do if they would have to take responsibility for the waste by their own. A shared responsibility might be enough to reduce the return rate.

Full Rights of Return Contracts

Not surprising, all retail managers agreed on being satisfied with their existing bread supplier contracts. Retail stores' right to return bread have been described before in studies by Norden (2011) and Karlsvärd et al. (2008). They argued that this contract removes economical incentives for stores to order right amounts. In this way retailers don't have to take any risks and they make money from the bread they sell. They have full rights of return up to a certain limit of sales; if this term hadn't existed waste levels would probably have exceeded todays level. The full right of return contract seems to have existed for such long time that it is regarded as the only solution at this point. Retailers no longer think of why it is formed in the way it is or if there are any other solutions. A change will probably have to be suggested and worked for by producers, since retailers are as satisfied with the current situation. Further, a change might need the whole bread-producing industry to agree on a general approach that all parties have to follow. Otherwise a few suppliers might continue to offer full rights of return contracts, especially since it obviously is possible to make money while having this contract.

Reasons for Full Rights of Return Contracts

Retailers feeling too scared to order bread seems like a poor reason for having this contract. In some relations with producers the contract doesn't exist and in those cases retailers manage to order bread. It would be interesting to find out if the amount of waste differs in the two cases; with and without this contract. The contract does provide a difference in terms of whom that is responsible for the waste and will have to compensate for this financial loss. If the producers manage this today by increasing the price on bread, this would probably be possible for retailers to. In the end the price on bread for consumers might not be any different from todays level. One thing that might change is, as discussed before, the amount of bread producers manage to sell to retailers if retailers are responsible for leftover bread. The question is whether another contract would be less profitable for producers. Maybe the best thing would be to find some sort of compromise where both parties have shared responsibility in another way than today.

Further, retailers do order other perishables that they don't have this kind of contract on, are they scared to do that as well? Retailers either seem to think this contract does not affect producers negatively, or at all. Producers just have to charge

a higher price on their products to compensate for return losses and then the problem is solved. This way of thinking doesn't really consider that wasted amounts can have a negative impact on other factors than the economy, for instance the environment.

Full Rights of Return and Bread Waste

The fact that retailers had a hard time imagining how waste amounts would change without this contract imply that they haven't given this scenario much of a thought. Since the waste is someone else's problem they don't seem to worry about how the amounts can be reduced. Anyway, a non-existence of the return contract would probably reduce sold amounts of industry produced bread to some level, due to re-prioritization, as was stated by retailers. In the end though, consumers' demand control what is sold in stores. Consumers demanding a certain product will force retailers to provide that product, otherwise consumers might choose another retailer. The question is whether bread consumers are loyal and always buy the same bread or if they are satisfied with whatever brand. In the latter case retailers don't have that much to lose on not having the contract – in terms of sales absent due to consumers choosing other stores. It was however interesting to realize that consumers buying bread also pay for bread thrown away. This might be the way it has to work when the full rights of return contract is applied. Otherwise producers would not be able to compensate for losses due to returns.

How Producers can Reduce Return Rates

Retailers seem to believe producers can improve when it comes to ordering appropriate amounts of bread. Then it might help if retailers contribute with complete information from their cashier systems. Some already do but an increased sharing in general could help to predict sales rate, make appropriate orders and thus reduce the amount of wasted bread. Existence of the full rights of return contract probably results in the lack of interest among retailers to take part in the work to place correct orders.

Impact of Order Size

Norden (2011) implies that an opportunity to order small amounts of bread is advantageous since it can help keeping low return rates in stores. This was possible in all stores where interviews were carried out. It was thought of as a way to provide proper amount of bread in stores. This opportunity is probably very important, especially when the assortment is as wide as it is today. A broad assortment of bread also requires the retailer to have the possibility to buy just a few of each kind. Otherwise a few loafs of low-selling bread might have to be thrown away each day. No one would want this to happen. But if retailers were not allowed to buy small amounts they might have to reduce their assortment. Suppliers succeeding to remain in the retailers assortment can then have increased shares of the market and in this way gain from not letting them buy small amounts of bread. In addition to this one can consider that there might be other drawbacks with the possibility to order small amounts. If the orders are small, producers might have to produce smaller batches of bread and this would reduce the efficiency in terms of energy use etc. during production. Later, when transported to the store, small orders might

mean that trucks start of their daily route with less bread – thus not utilizing the whole space and having lower transport efficiency. In the end things like these just mentioned have to be put up against the value of small orders – thought to reduce the amount wasted bread. Bread-producing companies have probably already considered this and found that it is most valuable, and maybe also profitable, for them to offer the possibility to order small amounts of different types of bread.

4.2.4 Bread Waste – Results

Formation of Bread Waste

Retailers claimed that it happens that bread waste is formed in stores due to production errors in packaging, resulting in open packages – but it is not that common. Some defects can sometimes make the bread go moldy earlier than expected. Interviews revealed that more common reasons for bread waste formation in stores are that wrong amounts were ordered or that bread end up passing date-restrictions.

Amount of Bread Waste at Retailers

One retailer estimated their wasting rate to 2-2.5 % of sales, when it comes to the amount of bread waste for which retailers have the financial responsibility. Another thought their waste was probably less than that taken in return by bread producers. One retail manager stated that some amount of bread waste has to exist, and that a certain amount of waste is already included in the producers' budgets.

Time on Shelf

The amount of time bread is allowed to lie on shelves in stores is steered by directives from central levels in the different retailer chains. Suppliers are in addition to this allowed to have their own rules, as long as they keep within the timeframe set by the retailer. Interviews revealed retailers tend to have a broader time span in which bread is allowed to stay on shelves than times set by producers. The times varied; from one producer letting the bread stay only for two days from baking day, to those removing bread two-three days prior to best before date.

Retailers check that salesmen follow the rules set by the store. In this way handling by retail personnel, who also clean up and rotate bread on shelves, help keeping down return rates. If retailers didn't care, more bread probably would have gone to waste. Only one out of three retailers stated that the amount of waste is affected by handling of retail personnel.

Retailers' Interest in Reducing Waste

None of the retailers considered waste of bread an issue but they did feel responsible, together with producers, to reduce the amount of wasted bread. They stated that they are really interested in keeping waste amounts as low as possible. At this point they do stuff like assisting in ordering and providing statistics to help salesmen predict consumption and arrange most beneficial placement of bread in

the store. In one store the bread department had been reduced in order to make it tighter and make shelves appear to be full even though they have less bread in the store.

Retailers agreed they might improve when it comes to "reproduction" of their own bread. Nowadays some left overs are used to make biscuits or breadcrumbs but new solutions are needed in order to come up with something valuable.

Consumers and Promotion in Stores

Consumers' choice of products is definitely regarded to affect the amount of wasted bread. When consumers choose products with longest best before date or only the ones baked today they most certainly leave some bread behind on the shelf. Retailers did not know how or did not think they can make consumers change their behavior. Partly due to that consumers want to buy fresh bread and partly due to that they are so fixed with date labels, and these things are really the same thing.

Reduced Assortment

Two out of three retailers thought that a reduced assortment later in the day could help reducing waste amounts. One suggested that a reduced assortment in general would reduce total waste. On the other hand, it was also discussed that a reduced assortment in one store could make its consumers purchase their bread in other stores instead. Retailers claimed that they don't overproduce their own or bake-off bread just to satisfy consumers' expectations with full shelves. It was pointed out that in some cases retailers accept that they run out of certain products and will have to face the rest of the day with empty shelves. This was mentioned as an example for breakfast buns.

Price Reductions to Reduce Bread Waste

None of the participating retailers reduced the price on bread that is closing its best before date. Two of them thought this was due to the full rights of return contract. It was also mentioned that their interest is to sell fresh products and not have the store filled with crappy products that can be sold cheaper.

Bread Consumption Trends

Retailers felt that the trend goes towards more half-baked or fresh unpacked bread. Some years ago Modified Atmosphere Packages (MAP), to prolong shelf life, were available on the market. These were no big seller and today they only remain in the areas of baguettes or specialized bread e.g. bread for people with gluten allergy.

Waste Handling

When it comes to handling of bread waste, salesmen take back returns to producers and the store handle waste from bread they produce by their own. In the morning retailers throw away what was left from the day before.

Since all stores had full rights of return contracts most of the bread waste was also taken back by salesmen and handled by the producing companies. Retailers didn't know how this was handled. One of them even claimed that salesmen often throw away the bread in retailer's own waste bins after they exit the store. Bake-off bread or own-produced bread on the other hand, the retailer has to take care of by themselves.

Two retailers disposed bread in organic disposal bins. The third threw bread to incineration, actually they did have an organic waste bin going to biogas production but the bread was thought to take up too much space to be thrown in there. One retailer used to give their bread waste to charity but it ended up in the wrong hands and was considered as bad-will for the company, thus it had to stop.

Future Measures

All retailers participating had goals on reducing waste. As for their sales they had a budget on their waste. It was mentioned that perishables like bread, fruit, vegetables and meat are large contributors and they have to be careful with these products.

4.2.5 Bread Waste – Discussion

Formation of Bread Waste

Bread wasted in retail stores due to wrong handling doesn't seem that common. Probably due to that bread not require as specific storage conditions as chilled products like meat and dairy. Bread is neither especially sensitive to physical hazards like fruit and vegetables. These things might be rather obvious, and the interesting thing is really to find out what do form bread waste in retail stores.

Problems with ordering does again seem to be the number one reason that causes bread waste formation in retail stores. This can indirect lead to that bread end up passing date-restrictions and forced to be taken in return. Behavior of consumers also affects what bread is left on shelves. In the end, it is consumers who choose which products to buy, and also which products not to buy. Norden (2011) and Naturvårdsverket (2008) also reported that their interviews with shops conclude that challenges with ordering are the most important causes for food losses in general. This was especially true when it came to fresh food and perishables. They conclude that this is due to difficulties in predicting what customers will buy. Factors as weather, season, offer of the week and the general mood of consumers were mentioned to impact their consumption habits. Norden (2011) further state that shops prioritize developing new methods to predict consumers' purchases and systems with information that enables this prediction. Measures like this can probably be really helpful to ease ordering. It will require though, that the retailer is interested in lowering return rates even though it is the producer who handle the waste and increase the price on bread for consumers to compensate for the financial loss. Due to this it might be a larger struggle to motivate retailers participating in development of new prediction models concerning bread than other kinds of products on which they don't have full rights of return.

Amount of Bread Waste at Retailers

It does not seem that strange if retailers waste less bread than the amounts going in return to suppliers. With bake-off bread there is a possibility to take out as much as you like from the freezer, at any time, and bake in the store. This can be done several times a day to adjust to fluctuations in consumption patterns. Even though this kind of bread only have one day to be sold during, unlike packed bread from suppliers, it would not be surprising if it was easier to produce the right amount and throw away less. With bake-off there also comes some drawbacks. It is hard to accomplish the same quality and feeling with bread that has been frozen compared to fresh. Further, bake-off bread demands space in a freezer and the freezer consumes energy that would not be consumed for fresh bread. On the other hand, a larger amount of bake-off bread could be delivered more seldom than fresh bread and this might reduce transportation emissions. Bake-off bread does however demand more work from retailers and this handling can impact labor costs.

Anyhow, it was interesting to find out that one of the retail managers believed some amount of waste has to exist. On beforehand one could imagine that all parties in the chain work to keep the amount of wasted food as close to zero as possible. This can still be the fact, but this statement makes you doubt on it. It might not be possible to reach zero waste of bread, but ratios lower than those today is probably possible in all ways. It might be hard though if some parties have the attitude than some waste have to exist.

Time on Shelf

Time-rules set by retailers was fairly long (a few days before best before date) compared to those from producers (varying from 2 days after baking day to 2 days prior to best before date). Since each producer is allowed to set rules within the timeframe this can be a way for them to steer the waste amount into becoming as low as possible. Long time on shelf would give more time for the bread to be purchased. On the other hand, freshness can be a part of the business idea – a more or less strong one for the different suppliers. If freshness is part of a retailers' image, a long time on shelf is not an option. Maybe the time on shelf doesn't matter that much since consumer tend to buy only the fresh bread, but if all bread on shelves were older consumers would be forced to buy it (or buy no bread at all). In this case retail personnel would only refill shelves when most of the older bread had been sold out. This would require more work from retail people to keep track on where to refill and not. One can wonder whether consumers would be ok with this concept. If they are opposing there will probably almost instantly be producers and retailers that are willing to go back to the existing system to get happy customers. In the end, that is one of their main business goals. To get the system with refilled shelves when most old bread is sold to work, there might have to exist some kind of legislation or rules, otherwise some parties will change according to consumers will. It does feel somewhat harsh to have this kind of legislation on sales of bread, but it might be needed in order to reduce the waste amounts. The question is if this issue is important enough for any of the parties in the supply chain. It would be interesting to know how certain companies sales would change if they prolonged or reduced their timeframes bread is allowed to be placed on shelves.

It was kind of interesting that only one of the three interviewed retailers thought of the fact that handling by their own personnel actually affect the amount of waste in a good way. When this question was asked the other retailers seemed to think it only was aiming to investigate how their personnel's handling affect the amount of waste in a negative way. It is important to point out the fact that the handling by personnel is a crucial function. By strengthening this fact one can also imagine that the personnel's awareness can impact their performance on this task.

Retailers' Interest in Reducing Waste

It is not a secret that retailers also want to keep down waste rates; at least for bread waste that they are responsible to handle, it has to do with their profitability. As was discussed by Norden (2011) the main focus in the retail sector is to sell and make money, this does not always go hand in hand with reducing the amount of food waste.

It is however hard to tell how much retailers really care since they many times have a return contract and no responsibility for a large quantity of the bread waste. It sounds good to say that you are really interested in keeping down waste amounts and that you have the responsibility together with producers to improve. At the same time no one of the respondents said they consider bread waste an issue in their store. This is a bit contradictory – they don't consider bread waste an issue but they still want to improve. Maybe waste amounts are not large enough to be considered an issue – and thus it is even more valuable that they struggle to improve. It might also have to do with that retailers don't want to state something about an issue. It might be interpreted like they have a problem with bread waste and they don't want to be connected with problems.

On the other hand, it seems like assisting in ordering is regarded as the most important way retailers can work to reduce return rates. Since ordering was pointed out as a main issue, it is a good thing retailers realize assisting to improve this is important.

If someone came up with a working concept for what to do with bread left overs, then it seems like retailers might be willing to implement this method. At this point though no concepts seems good enough for retailers to put in some extra effort. As long as it costs more than they lose on throwing bread in the bin they will probably not be willing to make this extra effort – remember them state they don't consider waste of bread an issue.

Consumers and Promotion in Stores

As is described by Naturvårdsverket (2008) consumers expect full shelves, thus retailers probably refill the shelves while some bread are left. When this new bread is available there is a large risk the ones with shorter date is not sold – consumers pick the new ones, and in this way waste is formed. Thus, it is really important that products are circulated and the ones with shortest dates are placed in front (Naturvårdsverket, 2008). It might be hard to change consumers' behavior, but maybe a narrower assortment would help by making some decisions for the consumer. To change the attitude of consumers instead be up to e.g. the Institute of

Bread or the National Food Agency. Retailers are all about making their customers, the consumers, happy. They will probably keep providing them with fresh bread in a varied assortment every day - at least as long as they have the full right to return bread to producers.

Reduced Assortment

Reduced assortment later in the day and also in general might, according to retailers, help reducing waste. This measure has its obstacles in consumers' expectation of shelves filled with fresh products at all times of the day. This means it might be hard to implement a change until consumers start to behave differently. As Norden (2011) concludes, no one will be willing to make a change that results in reduced sales. In the end the change has to start somewhere, whether it is with consumers behaving differently or retailers being braver and offering a reduced variety of products. Thus one way to begin finding a solution might be to reduce the assortment later in the day to find out if the sales rate really goes down due to this. Retailers doing this might be able to work out a system for reducing the price of bread since the waste, and economical losses, for producers might be decreased. Consumers would most certain appreciate a price reduction and that might be enough to make up for a reduced assortment.

Retailers didn't recognize the kind of overproduction described by Norden (2011) (shops produce 7 % more fresh bread than expected sales in order to meet expectations from consumers). They didn't seem to overproduce bread deliberately, or at least they didn't say they do. In order to make reductions of waste deliberate over productions to meet consumer expectations will probably have to be eliminated. Again, this require retailers to be more brave and make some decisions based on their own opinions of what's best for the environment.

Price Reductions to Reduce Bread Waste

To sell products closing its best before date cheaper has been stated as a measure to deal with the waste creation by, among others, Naturvårdsverket (2008). The fact that retailers didn't reduce the price on bread closing its best before date most certainly has to do with the full rights of contract. The retailers don't lose money on bread they don't sell, like they do on most other products. Also, they might not want to do this since they are afraid of missing opportunities to sell full priced products. If retailers didn't have the full rights of return contract the possibility that they sold out this bread to a lower price might increase. This could mean reduced income for the retailer, but at least a gain for the environment. Another factor discussed by Norden (2011) is that stores might be worried about getting a stamp that they sell crappy stuff. This was confirmed in interviews in this survey. Maybe by educating personnel about the importance of waste, as suggested by Naturvårdsverket (2008) can move the focus on something more important – the effects on the environment.

Bread Consumption Trends

MAP was a packaging feature that might have worked if consumers weren't demanding fresh bread to such vast degree, but now they seem to do. This might call for other packaging features than those prolonging shelf life. If the trend goes

towards more unpacked bread it might not be important with new packaging features. At this time though, it should be remembered that the market for packed bread in Sweden is still huge. In addition, unpacked bread is often brought home in some kind of transport packaging; maybe this has the potential for improvement as well.

Norden (2011) describes the situation today, where consumers are suspicious to food with long best before dates since it often can be connected to additives. This has made the trend go in the other direction – to shorter and shorter dates. Maybe this has always been the fact for bread since consumers seem to want it as fresh as possible. On the other hand, interviews showed retailers confirming the trends with increased consumption of half-baked bread that was presented by Jordbruksverket (2009). How fresh is the bread that has been half-baked and frozen and then baked shortly in the shop? Are consumers aware of what kind of bread they buy? Retailers stated that this kind of bread together with fresh unpacked are increasing the shares on the bread market. Bake-off smells like fresh baked bread and this together with a crispy crust can probably explain why some consumers choose this kind of bread instead of packed fresh bread in the stores. Anyway, it does not agree with the "shorter and shorter date trend" and consumers willingness to buy fresh bread. Further, it might be possible for bread to stay fresh and more natural if it is well packed compared to frozen half-baked and unpacked bread. This might not have occurred to consumers.

Waste Handling

The fact that salesmen return bread past date restrictions might mean that retailers are less aware of the amount than if they would handle it by themselves. This is probably true especially if amounts taken in return are greater than that thrown away in the store. Further, retailers didn't know how suppliers handle return bread. This suggests they don't really care how this is achieved. It seems to be beyond their interest, and they probably don't have anything do say that can change the current methods. However, one could think they should have the interest knowing what happens with all the returned bread. It does seem a bit strange if some salesmen throw away return bread in the bins of retailers. One could expect them to be careful not to act in a way that might give their company bad publicity. If someone finds all this bread in a bin instead of it being treated as it is supposed to, and also if there are certain rules for how food should be sorted, that are broken, this might have large consequences.

When it comes to the retailers' own handling it was kind of surprising, and somewhat troubling, to find out that some bread is sent to incineration instead of biogas production only due to that it takes up too much space in the bin. This is probably a question of money; if it is more expensive to send organics to biogas production the choice of waste handling method might be easy for some retailers. It might be that if they throw bread taking up much space in the bin, they have to get the bin emptied more often and that might be more expensive. In general, separated food waste should be less expensive to get taken care of than mixed waste in order to get retailers to sort out their waste.

Future Measures

Waste amounts of bread that is not included in return contracts affects the profitability of retail stores. When retailers stated they didn't want to waste bread it can be suspected that they mainly thought of the bread waste they themselves are responsible for. Not that fraction taken in return by producing companies – that was up to others to deal with. This has to be pointed out.

Further, it is once again somewhat contradicting that retailers stated that bread waste is not an issue while at the same time explaining that bread together with other perishables are large contributors to waste formation and have to be dealt carefully. Maybe, if perishables like bread were not handled carefully, the waste might have turned out to be an issue. Thus, it is understandable that they pointed out perishables as important waste creators. As discussed before, it might have had to do with retailers not wanting to state that there were any issues, even if that wasn't what the question was really about. It was rather an attempt to realize what picture retailers have of bread waste than to point out if they are having any problems with bread waste. Maybe if the question was rephrased and this difference was made clear, the answers would have been different.

4.2.6 Packaging – Results

Current Packaging System

Retailers didn't have any real ideas or thoughts about existing packaging systems used for bread. There was nothing they would like to change and no one thought the quality of packaging had changed to the worse lately.

Impact of Packaging in Bread Waste Formation

When judging to what degree bread waste can be related to the packaging all retailers agreed that the packaging size is not related to this. They thought packaging sizes today are varied and in addition to this most people have the possibility freeze half the bread if they know they won't be able to finish it in time. One really pushed that date labeling has a large impact in this issue and the other two didn't think the choice of date labeling system affects the amount of waste. Further, none of them had any idea of how a packaging should look to prevent the formation of bread waste.

Finally all retailers agreed that if a packaging change would be implemented, like a change of date labeling system or variance of sizes (suggestions from consumer surveys), this would not be any problem for them. They were clear on this point - as long as their consumers are satisfied, they are satisfied.

Future

Retailers could not account for any ongoing discussion with suppliers regarding future changes in bread packaging performance. When they were asked to think about the future only a few ideas of how the packaging might develop were discussed. Someone thought the trend will go towards even more unpacked bread

and maybe towards smaller packages. Another stated that there will not be any large difference "What other than plastics are there?".

4.2.7 Packaging – Discussion

Current Packaging System

When discussing current bread packaging systems with retailers they didn't have any strong opinions or thoughts to share. Retailers didn't seem to care that much about this. As long as their customers are satisfied – they are satisfied. Retailers don't really come in contact with transport packaging since producers themselves bring bread up in shelves. Thus, it is not really strange that they had this attitude. Apparently there is nothing about bread packages that retailers would like to change; maybe the situation would have been different if they handled bread to the same degree as other product types.

Naturvårdsverket (2008) reported that transport packages had been found to gain a reduced quality lately. They connected this to a struggle to minimize the amount of packaging material in order to gain economic and environmental benefits. In this study though, retailers didn't think packaging quality had changed lately. This might mean that it hasn't changed, or again, that this is beyond retailers' interest. They barely handle the packages – so they might have a hard time making a fair judgment of this. Also, since they have quite a close relation with producers, if there really were something they would like to change they would probably tell this to the salesmen directly.

Impact of Packaging in Bread Waste Formation

In general, retailers didn't make such big connection between bread packaging and waste. At the same time they didn't seem to have thought about these kinds of questions before and struggled to imagine in what way packaging could affect waste. It could also be that they really think that there is no connection between these two. It wasn't strange that they did not have any idea of how a packaging should look to prevent more waste. Especially since they didn't think there is a problem with the existing packaging or that there is any strong connection with waste formation. There is an ongoing discussion whether food should be labeled with best before or any other system. Interviews showed that retailers don't really think this matters. However, the Consumer Association of Stockholm (2009) reported that 62 % of consumers preferred food to be label with "at least preservable until" instead of "best before". The question is whether a change in system would make consumers waste less. To find out it might be needed to make a survey studying consumers' behavior instead of asking them questions. After all, it is probably a difference between how people state labels affect them and how they really behave in relation to them. Maybe it is more important to spread the real meaning of the label instead of changing it to another system.

Not surprisingly retailers wanted to adjust to and please their consumers' demands. One could wish that this could be accomplished with the environmental impact from waste kept in mind more often.

Future

The lack of thoughts regarding the future of bread packaging can have to do with that retailers haven't considered these things before. If they had time to think they might come up with some ideas. Anyway, retailers seem to think that packages are suppliers' responsibility and this would help explaining the reason for their lack of interest.

4.2.8 Finish – Results

Main Issue Creating Waste

As a summary retailers were asked to state what they consider the main issue creating bread waste in the retail phase. Reasons reported were:

1) Too large assortment.
2) Problems in ordering the right amounts.
3) Too large deliveries.

Possible Solutions

Further, retailers' solutions to reduce these problems were:

1) Narrowing down the product range.
2) Higher awareness of changes in sales rate among producers.
3) Don't think there is any will to reduce wasting rates of bread. This cost is already included in their budget, and as long as they reach their budget everyone is satisfied. This might change if for example waste handling got really expensive.

4.2.9 Finish – Discussion

Main Issue Creating Waste

All three reasons declared as the main problem can be seen to depend on each other. In one way, a too large assortment together with other factors like weather and mood of consumers affect consumption patterns and makes it hard for salesmen to order right amount of bread. This leads to that too large orders of bread are delivered. In line with the conclusion by Norden (2008), problems with ordering seem to be the most important cause for bread losses in the retailing phase.

Possible Solutions

Both Norden (2011) and Naturvårdsverket (2008) suggest that education of personnel about the environmental and economic impact of food waste might be a possibility to reduce the wasted amounts. It might help to some degree - as was discussed earlier, handling by personnel in the store do have some impact on the amount of bread waste created – but again, it might be more up to educating salesmen or people at the producing company since they are the ones ordering the

bread. Retailers do however seem to think it is up to producers to change and solve the main problems forming bread waste.

4.2.10 Summary – Retail

A large fraction of wasted bread is formed in retail stores as unsold bread that has to be returned to producers. As a result of the full rights of return contract retailers don't lose money on returns until they exceed a certain percentage of the total sales. Further, the contract allows producers themselves to decide how much bread they want to bring to each store. In order for producers to reduce their waste amounts retailers suggested a reduced assortment and more careful ordering. Today retailers sometimes assist in placing orders and producers have varying possibilities to take part of information from their cashier systems. It seems possible for this work to be performed in a stronger co-operation and then it might affect the amount of bread returned from retail stores.

There is usually not a direct relation between the packaging and waste formation in retail stores. Retailers tend not to be as interested or have thoughts about the packaging system as producers or consumers. Retailers don't really come in contact with bread packages in the same way as with other products since producers themselves bring bread to the retail shelves. Thus, it is not really strange that they had this attitude. Apparently there is nothing about bread packages that retailers would like to change; maybe the situation would have been different if they handled bread to the same degree as other product types. Handling by retailers in the store do however affect the amount of waste, they move bread on shelves and see to that it looks appealing during the rest of the day. Retailers stated that the waste formation is compensated for by producers through a higher price on their products – meaning that consumers buying bread also pay for bread that is wasted.

Retailers seem to apply a more economical way of thinking related to waste than to consider impacts on the environment. For retailers, the main goal is to satisfy the needs of their customers – consumers. The packaging does however have strong influence on the behavior of consumers and thus indirectly affects the amount of bread waste that is formed in retail stores. Retailers did however not believe that a change in bread packaging sizes would help reducing waste and only one out of three thought another date labeling system would help. To summarize, retailers did not relate bread waste formation with packaging but perceived it more as a problem of ordering the appropriate amount of bread.

4.3 Consumer Questionnaire

The questionnaire used in the consumer interviews is presented in Appendix 3 – Consumer Questionnaire. Results from the consumer survey are presented in the following sections with questions divided into relevant topics. After each corresponding figure, a discussion and comparison with other literature is presented. In total 50 consumers participated in the survey. Thus, one consumer correlates to two percentages of the total amount of respondents.

4.3.1 Basic Information of Respondents

In the initial interview phase, gender, age and number of people in the household of the respondents were noted. Figure 8 presents a summary of these three socio-demographic factors; more detailed information is available in Appendix 4 – Socio-demographic factors for respondents in each shop. More than 60 % of the interviewees were females. 66 % were in the age of 26 to 55 years. 9 out of 50 lived in single households and almost 50 % of the respondents lived in households with three or more people.

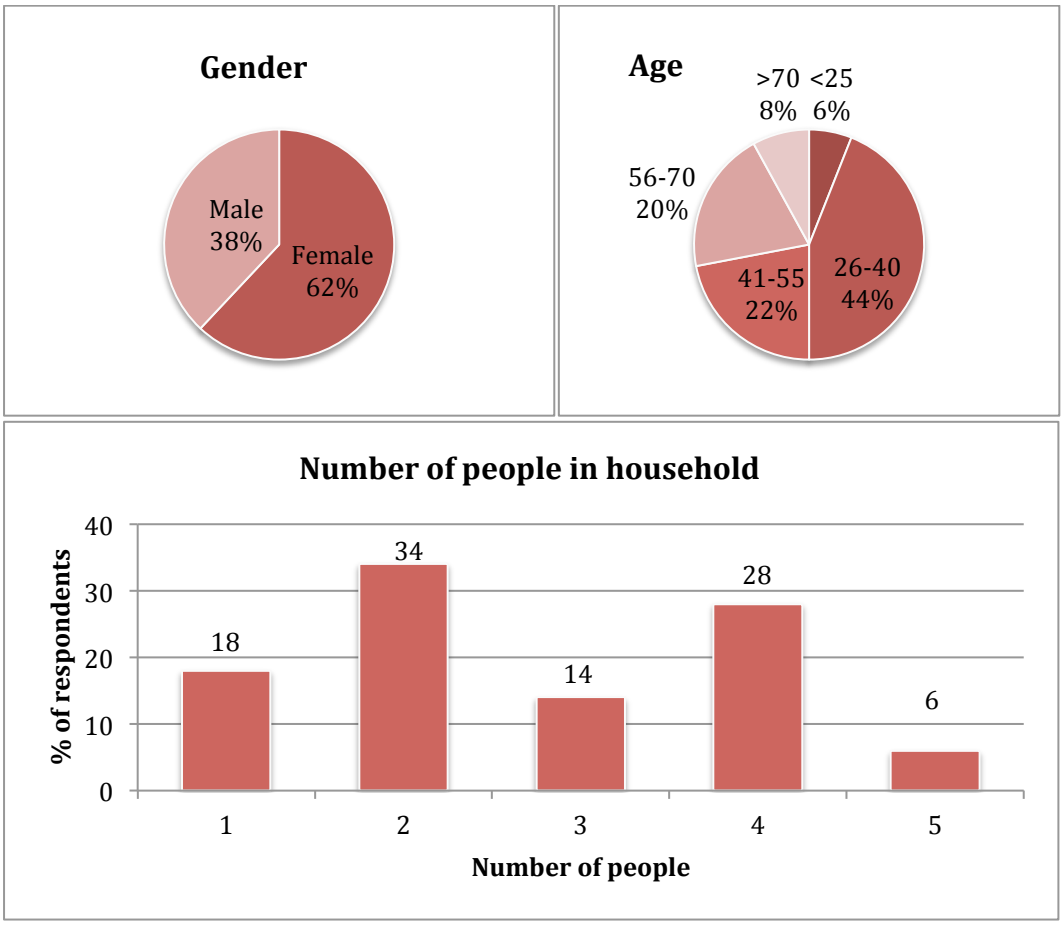

Figure 8. Gender, age and number of people in the household of consumers participating in the survey.

As described in the methodology section, interviews were carried out at stores in different parts of town and at varying days and time. However, some demographic groups have most certainly not been included in this survey. Those shopping in evenings and on weekends are the most obvious ones, and people buying bread in smaller shops have also been excluded by using this approach.

4.3.2 Questions Concerning Purchase and Wastage of Bread

Question 1: How much bread do you buy?

After the initial questions above, interviewees were asked to estimate how much packed respectively unpacked bread they buy to their households. They estimated

the amounts of bread in loaf units. Figure 9 presents the results, packed bread represented by the staples in darker orange and unpacked bread by the lighter ones.

78 % of the respondents said they buy one or more loafs of packed bread per week, the corresponding number for unpacked bread was 42 %. When the total amount of bread purchased per month for all 50 respondents was summarized it was concluded that almost twice as much packed bread compared to unpacked bread was bought (226 loafs packed compared to 115 loafs unpacked). Further, 26 % stated they buy no unpacked bread whatsoever, the corresponding number for packed bread - 8 %, was much lower.

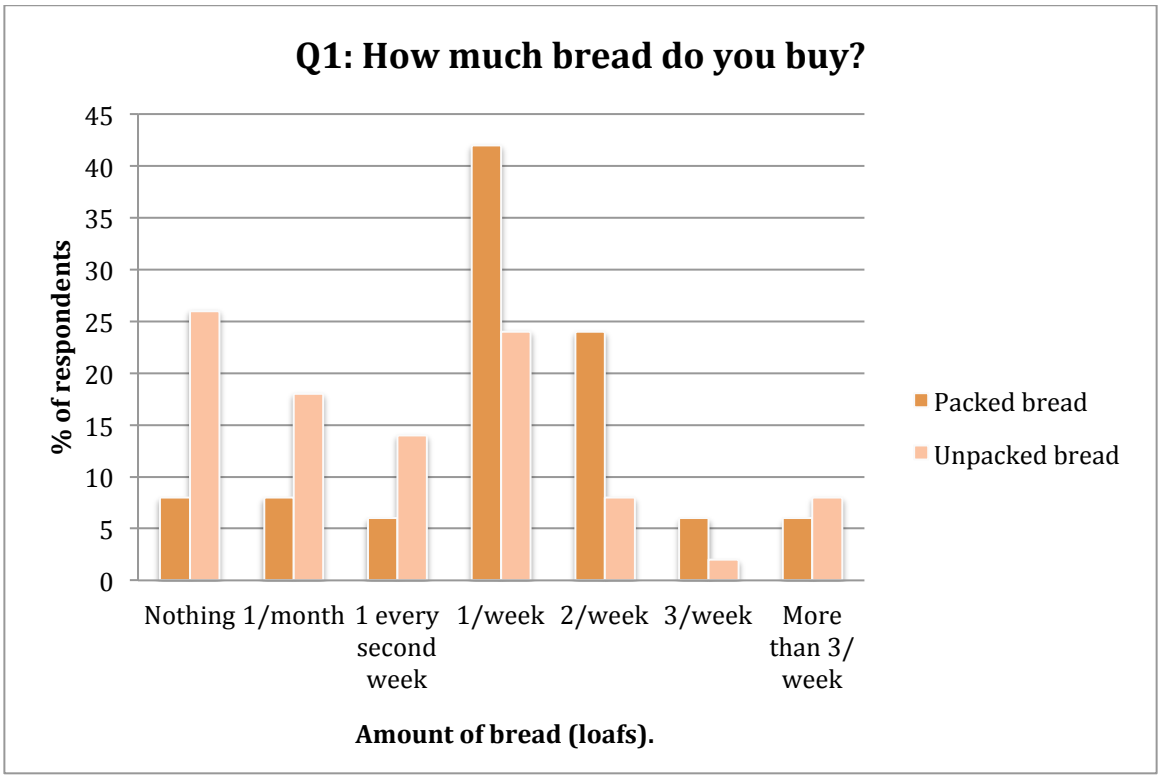

Figure 9. Answers to Question 1, darker staples representing % of respondents for packed bread and lighter staples representing unpacked bread.

Even if the trend moves towards more unpacked bread, packed still seem to be the most popular choice among consumers buying their bread in retail stores. On the other hand, consumers buying more of unpacked bread might do their purchases in smaller specialized bakeries – and they are not included in this survey.

To give a more detailed picture of which groups of consumers that have different purchasing habits, Figure 10 and Figure 11 was constructed. Here results from Question 1 are presented according to what store consumers were interviewed in and number of people in household.

Figure 10 presents purchased amount of packed bread. It can be seen that buying habits of consumers interviewed at City Gross differentiate somewhat to that in other stores. In this group more people buy two loafs or more per week than in the

other stores. Consumers living in households with one or two people don't buy more than two loafs per week. It can also be noted that in single households all respondents say they buy packed bread.

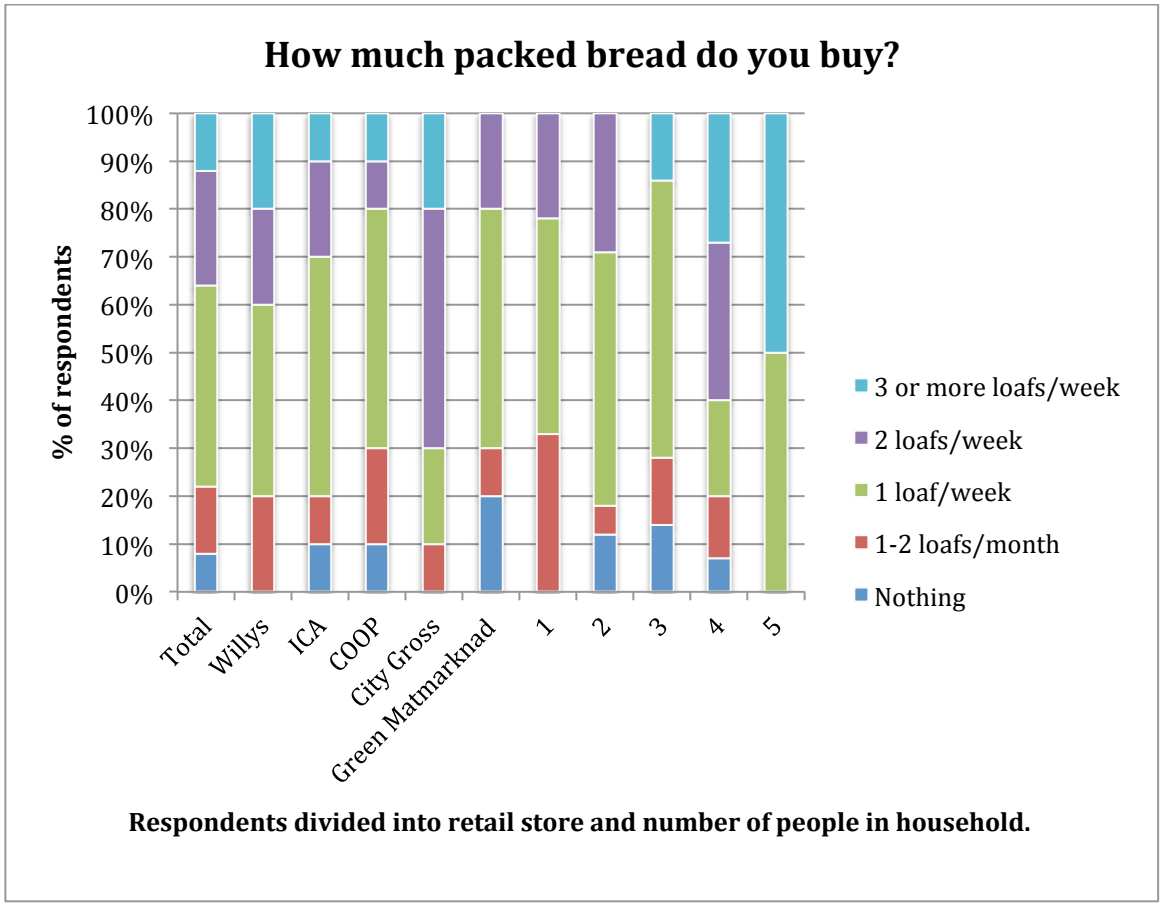

Figure 10. Amounts of packed bread purchased by consumers, divided into the five retail stores and to number of people in their household. Amounts of purchased bread range from nothing to 3 or more loafs per week.

It is hard to draw any conclusions about differences in purchasing habits between the different groups of consumers. If a larger number of respondents were included this might have been possible. These results could then have been further used together with data on wasting rates in different groups in order to examine whether high-purchasers also are high-wasters or if those consumers buying bread more seldom tend to end up throwing larger fractions away.

Figure 11 presents purchased amount of unpacked bread. Also here it can be seen that buying habits of consumers interviewed at City Gross differentiate somewhat to that in other stores. 60 % state they buy no unpacked bread at all, while at COOP no one said they don't buy unpacked bread. It should be noted that 64 % of people living in single households don't buy unpacked bread.

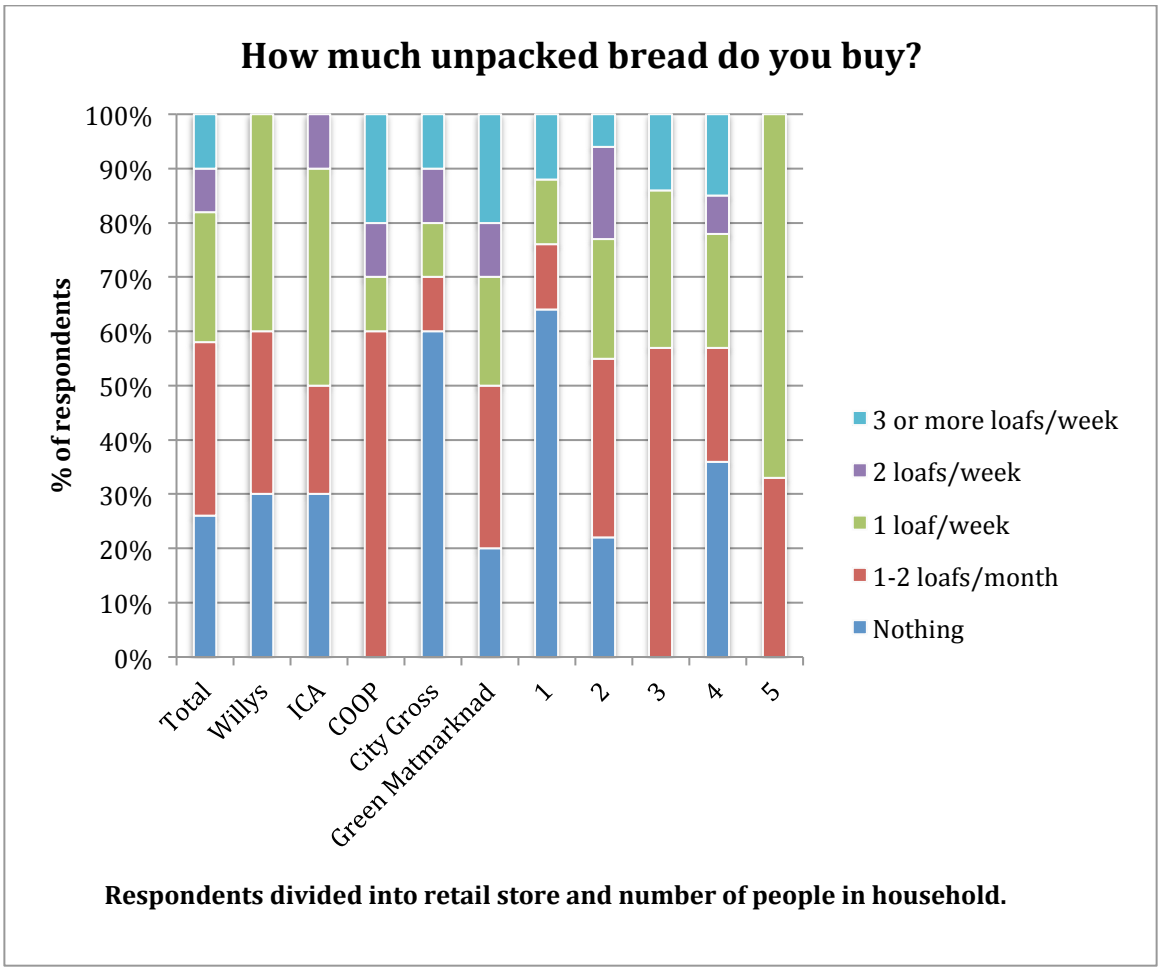

Figure 11. Amounts of packed bread purchased by consumers, divided into the five retail stores and to number of people in their household. Amounts of purchased bread range from nothing to 3 or more loafs per week.

The fact that 60 % of respondents at City Gross stated they don't purchase unpacked bread can have its explanations. In this store the packed and unpacked bread departments are separated more distinguished than in other stores. Since most consumers were interviewed at the packed bread department this might have excluded people buying unpacked bread. Further, it can be seen that there is a large difference between the amounts of packed and unpacked bread purchased by single households. All interviewed single households buy packed bread but as much as 64 % don't buy unpacked bread. This might be due to that unpacked bread has a shorter shelf life and thus if living alone one might not have time to finish it before it gets ruined.

Question 2: How much bread do you waste?

After estimating purchasing amounts respondents were also asked to estimate how much bread they waste. This was done on a scale from "none" to quite a lot" in order to provide results comparable to those from Cox and Downing (2007). Figure 12 presents results on bread wastage, packed bread represented by staples in darker orange and unpacked bread by brighter staples.

No respondent stated they waste quite a lot of bread, neither packed nor unpacked. The majority declared they waste none or hardly any, of both types of bread, with packed bread being thrown away to a somewhat higher degree than unpacked.

Figure 12. Answers to Question 2, darker staples representing % of respondents for packed bread and lighter staples representing unpacked bread.

Results can be compared to those in the study made by Cox and Downing (2007). Table 11 presents wasted amount of packed and unpacked bread from this survey and wasted amounts of bread and cakes from the study by Cox and Downing (2007). Amounts of waste were grouped into "Minor" (none and hardly any), "Moderate" (a little) and "Significant" (some, a reasonable amount and quite a lot) amounts as those categories used in the study by Cox and Downing (2007). About the same percentage of consumers declared wasting a moderate amount. The difference from this study with that from the UK was the amount stating they waste minor and significant amounts. What this might be due to is hard to say. Maybe it has something to do with that cakes was included in the UK study and that cakes are thrown away in a higher degree than normal bread. Otherwise Swedes might waste less bread than British people, or at least state that they do when asked.

Table 12. Wasted amounts of bread by consumers; amounts of packed and unpacked bread from this survey and bread and cakes from Cox and Downing (2007). Minor (None and hardly any), Moderate (A little) and Significant (Some, a reasonable amount and quite a lot).

Type of bread	Minor (%)	Moderate (%)	Significant (%)
Packed (this study)	74	14	12
Unpacked (this study)	78	16	6
Bread and cakes (Cox and Downing, 2007)	64	16	20

To provide a more detailed picture of how much different groups of consumers waste, respondents were divided into fractions according to socio-demographic factors - gender, age and number of people in household. Then the wasted amounts in each group were calculated. Results for packed bread is presented in Figure 13 and unpacked bread in Figure 14.

Figure 13 shows that men waste somewhat more packed bread than women do. It shows that consumers 25 years or younger and older than 70 only waste minor amounts. Those 41-55 years showed to waste largest amounts. Single households waste less than households with two or four persons but more than households with three or five people.

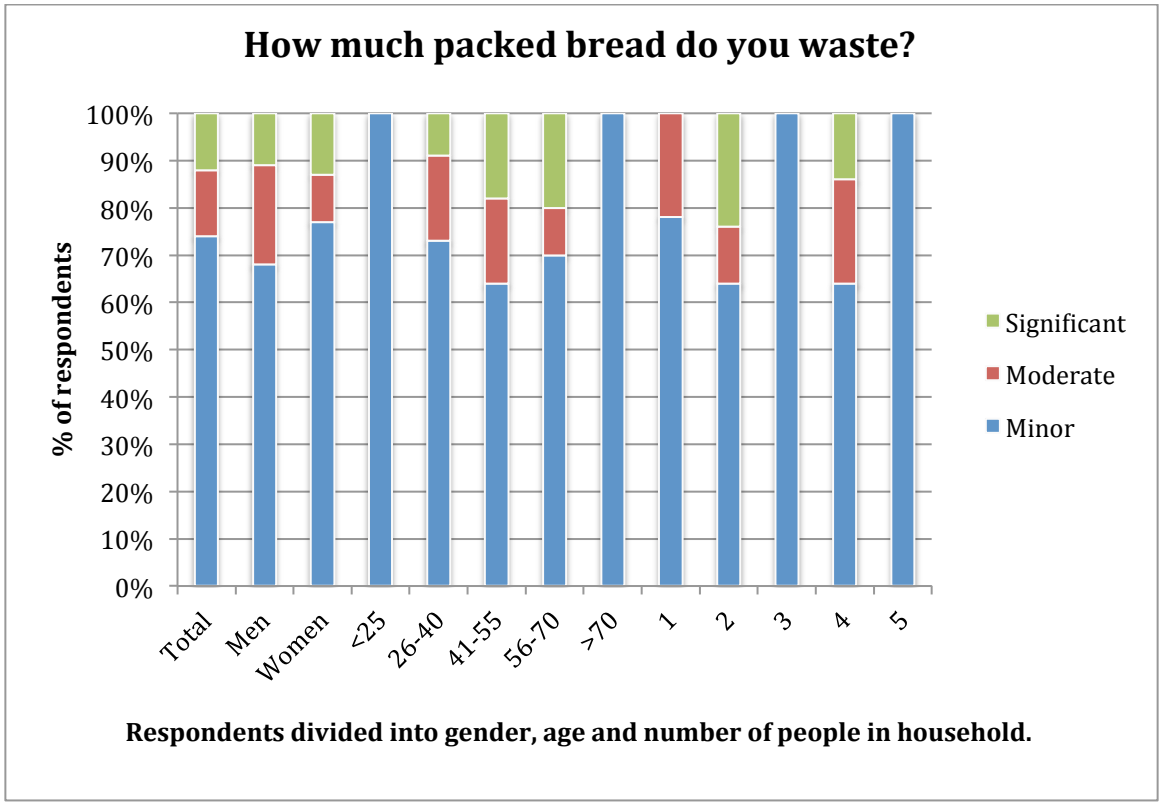

Figure 13. Amounts of packed bread wasted by the different groups of consumers, ranging from minor (none and hardly any) to moderate (a little) to significant (some, a reasonable amount and quite a lot).

When it comes to wastage of unpacked bread, Figure 14 show that men waste somewhat more than women. Consumers 70 years or older claim they waste only minor amounts of unpacked bread, as well as packed. Those under 25 years only waste minor or moderate amounts. Further, as well as with packed bread, consumers in the 41-55 year-old-group tend to waste the most. Larger households seem to waste less – smaller to waste more.

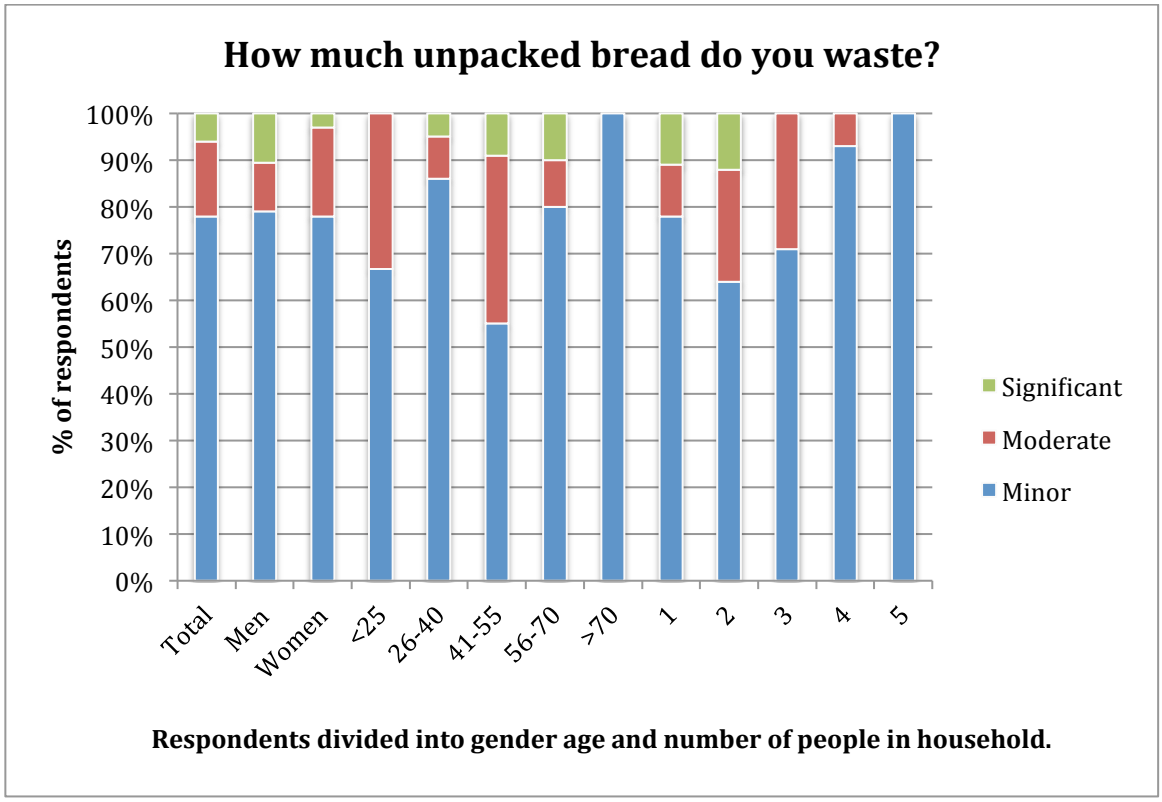

Figure 14. Amounts of packed bread wasted by the different groups of consumers, ranging from minor (none and hardly any) to moderate (a little) to significant (some, a reasonable amount and quite a lot).

Since wasting bread probably is something consumers aren't proud of doing, results might be underreporting the actual amounts wasted. According to Cox and Downing (2007) men tend to waste somewhat more food than women. In line with results in this study, the difference between genders is rather small with men wasting somewhat more than women. When it comes to the age, consumers over 70 years were the ones reporting lowest wasting rates in this study. This correlates with Cox and Downing (2007) who report that people over 65 years say they don't waste – otherwise all people say they waste, irrespective of socio-demographic factors. This if further in line with Parfitt *et al.* (2010) who also claims that older people waste less than younger, but a change can be expected in the future. According to Cox and Downing (2007), high-wasters are more likely to be younger (<45 years) and live in larger households. The group wasting most according to this study was people in 41-55 years – not the youngest ones. It is unsure however whether this is because young people in Sweden actually waste less than young people in UK. It could also be due to that young people in Sweden are less aware, or less honest, about how much they waste.

Further, larger households sometimes declared lower wasting rates than smaller ones, but the results were a bit inconclusive. Single households don't seem to waste either most or less. Concerning packed bread single households waste less than 2 and 4 people households and more than 3 and 5 people. If more interviews had been performed with people living in 3 and 5 people households (at this point only 7 and 3 consumers respectively participated) the result might have been more conclusive in one way or another. If single households waste less than all others, there might not be that urgent need to change packaging sizes to smaller ones – the assortment on the market today might be various enough. In this case purchasing habits among larger households might be the real problem. It is probably harder for households with more than one people to estimate the amount of bread that will be consumed in the upcoming future. Furthermore, it might be more difficult for them to keep track of what kind and how much food that is available at home. This might make people in larger households have problems in planning their purchases as exact as single ones. One should not exclude the possibility that larger households also might buy smaller packages if they were available. This makes it possible for them to buy for examples one and a half packages per week if that is more suitable for their consumption.

It should also be remembered that the price might affect what packaging sizes people buy. Large packages often cost less money per weight than smaller ones. This can make people buy large packages even though they know beforehand they will not consume it all. This might be a problem with selling smaller packages. On the other hand, if people are somewhat aware of the impacts of food waste they will probably realize that a smaller packaging is the smartest choice for the environment. Also, if the smaller packaging is cheaper, per se – not per weight, than the larger one people who know they won't consume a large packaging will spare a few crowns on buying the smaller one. This can make some consumers go for the smaller packaging anyway.

There are single households wasting significant amounts of unpacked bread, this was not reported in households with three, four or five people. This might imply that it is hard for people living alone to buy unpacked bread in a size that suits their consumption patterns.

Question 3: What is the most common reason for you to throw away bread?

After estimating waste amounts, respondents were asked in two questions why they waste bread. The first question, with results presented in Figure 15, concerns the most obvious reasons of why bread is wasted. Answer alternatives were defined to enable comparison with Ventour (2008). Among the 35 consumers who declared wasting some amount of bread, bad appearance was given as the most prevalent reason. Mold and passage beyond best before date as the most common reason had similar answer frequency in the survey.

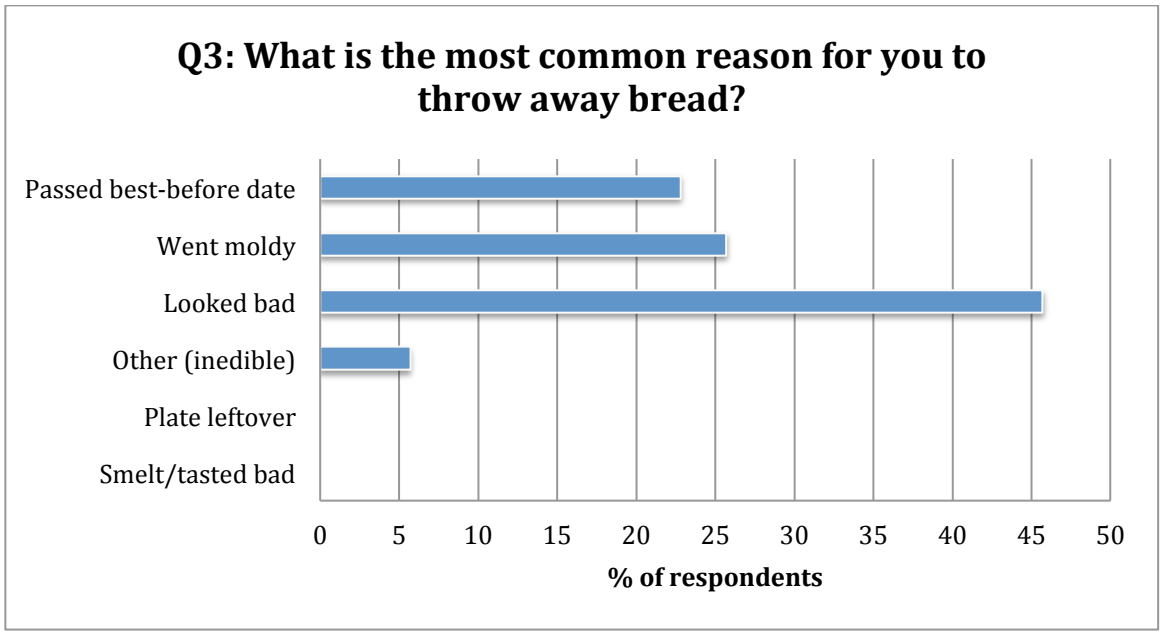

Figure 15. Answers to Question 3, each staple represents the number of respondents answering this alternative was the most common reason they wasted bread

When comparing results from this study with the one made by Ventour (2008) there are some distinct differences. Fewer people in the Swedish study designated passed best before date as the main reason they throw away bread than in the UK study (22.8 % compared to 29 %). Maybe Swedes care less about the date labeling than British people. Otherwise Swedes might care more about the appearance, and thus less about the date in the first place. This theory is supported by the fact that more than twice as many Swedes than British people declared that the bread looking bad was the most common reason for them to waste it. (In this category bread gone dry was included.) Additionally, no one in the Swedish survey stated plate leftover or bad taste/smell as the main reason for wastage. These differences might depend on varying bread consumption habits in the UK and Sweden.

In a study by the Consumer Association of Stockholm (2009) one third of the respondents stated that a common reason for them to waste food was that it had passed its best before date. Since that survey was designed in another way results cannot be compared directly with this study. It does provide an additional source showing that consumers use date labels to judge whether they should eat a foodstuff or not.

The fact that less than one of four consumers declared passed best before date as main reason can be compared to results from Question 5. Here consumers were asked how they use the date labeling when judging whether to eat bread. Results should preferably show that most people don't look at the date labeling or that they eat the bread even though they know it has passed its date.

Question 4: What of following is the most common underlying reason for you to waste bread?

Question 4 – the second question concerning wastage of bread, was aiming to find underlying reasons to Question 3. What, in the consumers opinion, made the bread

look bad, get moldy or pass best before date before they managed to eat it. In other words, what made them end up wasting the bread? The answer alternatives were formed with reviewed literature kept in mind:

- Too large bread packages can result in old bread simply due to the fact that consumers don´t manage to finish it in time.
- Poor bread quality could result in dry, moldy or bad smelling/tasting bread.
- Wrong storage at home, e.g. an unsealed plastic bag could result in dry or staled bread.
- Finally, if the bread already was a couple of days from baking day when purchased, this could for example lead to that it passed best before date prior to being consumed.

Figure 16 presents results, showing that almost 67 % of the respondents throwing away bread stated that too large bread packages were the main reason.

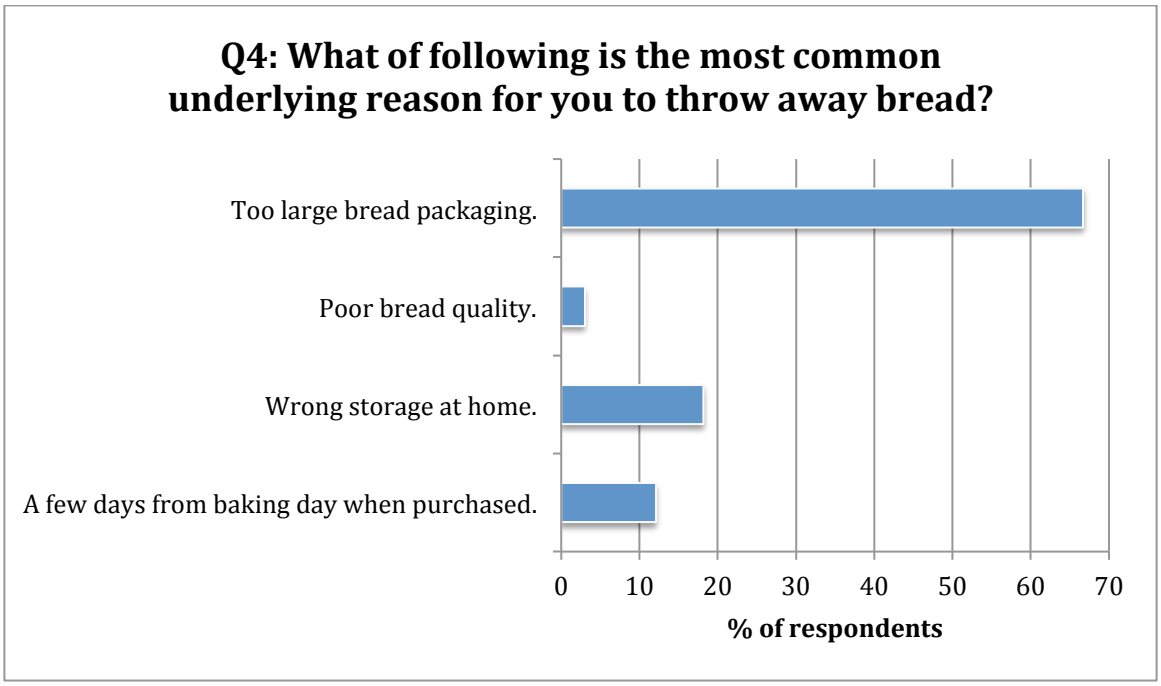

Figure 16. Answers to Question 4, each staple represents the number of respondents answering this alternative was the most common underlying reason they wasted bread.

It can be concluded that out of these four alternatives a major part, two thirds, of the respondents stated that too large bread packaging was the underlying reason for them to waste bread. Results from Question 2 regarding unpacked bread shows that smaller households tend to waste larger fractions. In this case smaller units of bread might help reducing the waste. When it came to packed bread households with two and four people stated they waste more than single ones. This suggests that too large packaging sizes might not be the main issue if one assumes that households with more people also consume more bread than single households. Maybe the real reason why they waste bread is because they tend to buy the wrong packages. It could also be due to that single households are better at storing bread so that it stay fresh: if you live alone and you buy a toast package, you might directly freeze half of

it because you know you cannot eat everything in one week. If you are two or three people you might think you can eat the whole package, but apparently you can´t. It might basically be easier to plan if you are alone, even if packaging sizes really are inappropriate for single households.

4.3.3 Questions Concerning Bread Packaging

Question 5: Thinking about how you use the dates on the labels of bread, which indicates how long the products will last for, which of the following statements best describes you?
Question 5 aimed to investigate how much consumers cared about the date labeling when judging whether to eat a bread or not. This question, and alternative answers, had the same design as a question in a study made by Cox and Downing (2007). This was to allow for comparison between Swedish consumers and British consumers in their survey.

Alternatives ranged from "I never eat bread that has passed its date label" to "I often do so". There was also a possibility to say, "I don't care to look at the label - I decide whether to eat it based on other grounds". Results are presented in Figure 17. Almost as many consumers stated they never eat bread if it has passed its best before date as consumers that don't look at the date label when judging whether to eat bread. More people stated they occasionally or often eat bread past its date label (32 %) than those never doing it (28 %).

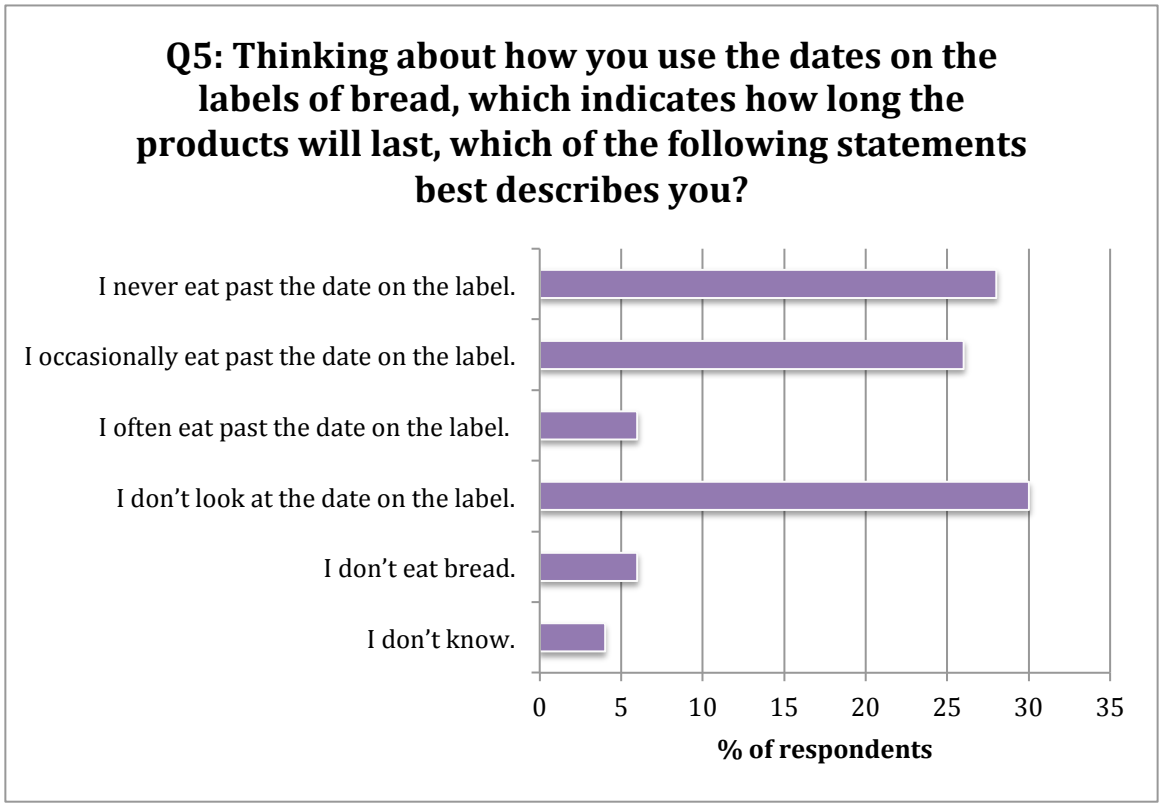

Figure 17. Answers to Question 5, each staple represents the number of respondents choosing each statement.

Table 12 below presents results from this survey and results from the survey by Cox and Downing (2007). In line with results on Question 3, where more British people gave passed best before date as the main reason for wastage, these results show that twice as many British people as Swedes never eat bread past its date. Six years have past since the British study was performed - some changes might have occurred on their market, but this is a rather convincing result. It suggests that British consumers might be more sensitive to date labels on bread than Swedes.

As many as 30 %, compared to only 2 % in the Cox and Downing study, don't look at the date on the label when judging whether to eat bread. Additionally, it was recorded that many consumers in this study look at the date labeling when they buy the bread. They want to check baking day and for how long the bread will last. After this point they don't care to look on the date label anymore – they decide by other means if they should consume the bread or not.

Table 13. Percentage of consumers responding on each alternative in this study and the study by Cox and Downing (2007).

Answer	This study	Cox and Downing
I never eat past date on label.	28	56
I occasionally eat past date on label.	26	32
I often eat past date on label.	6	9
I don't look at the date on the label.	30	2
I don't eat bread.	6	0
I don't know.	4	1

It is interesting to compare how much packed bread consumers waste related to what they answered on Question 5. Do consumers who never eat past the date waste more packed bread than others, as one could suspect? Figure 18 presents a comparison of wasting and how consumers use the date labeling on bread packages.

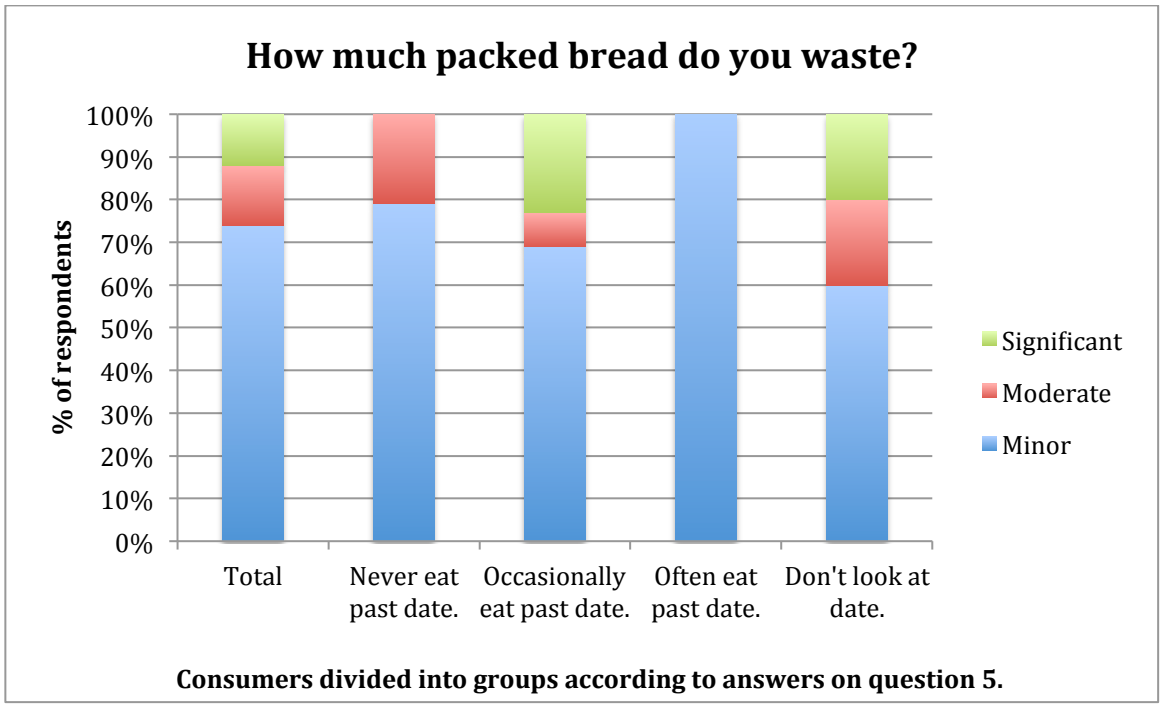

Figure 18. Wasting of packed bread related to consumers' way of using the date labelling when judging whether to consume bread or not.

It can be concluded that consumers wasting significant amounts belong to the groups that either occasionally eat past the date or don't look at the date label. These two groups also waste more than those who never eat past the date – maybe not as one could suspect. It could also be that those who never eat past the date are simply good in planning how much they will consume, or that these people actually lie about how much they actually waste. That can't be judged here. If, however, people following the date in a strict way waste less than those who don't look at it suggests that people who judge by other means might chose to waste bread even though it is within its date. Personal opinions about when bread no longer is suitable for consumption might sometimes occur earlier than the date label suggests. Since people not making their decision based on the date labeling tend to waste more than those who do, the date label in itself doesn't seem to be the main issue. It is still possible that another system for date labeling might reduce the amount of waste anyway, since almost 30 percent of consumers never eat bread past its best before date.

Question 6: To what extent do you recycle the bread packaging?

Question 6 concerns consumers' waste handling of bread packaging. Soft plastic packaging hasn't been possible to sort out with hard plastics for that long time in Sweden (VA SYD, 2012 a). Due to this it was considered interesting to examine to what extent bread consumers recycle the packaging. The alternatives ranged on a scale from "never" to "always" and results are presented in Figure 19 below. More than twice as many consumers stated they never recycle bread packaging (46 %) compared to those who always do (22 %).

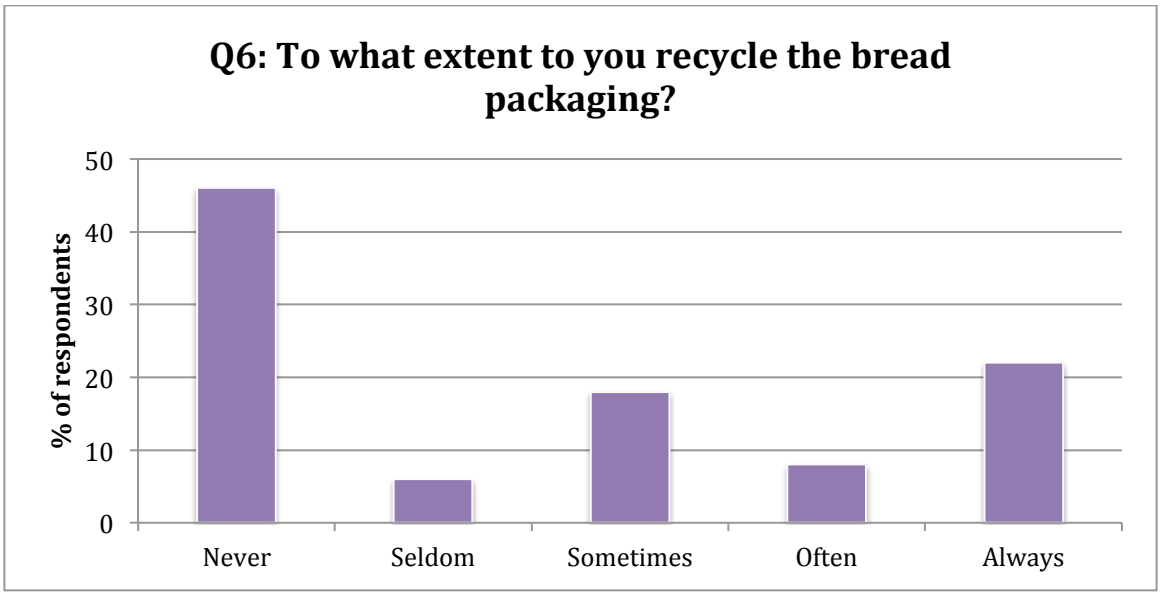

Figure 19. Answers to Question 6, each staple represents the number of respondents choosing each alternative.

No previous research on bread packaging recycling has been found – no comparison can be made. However, according to this study a large part of consumers never or seldom recycle the bread packaging. Maybe they are lazy and throw away the packaging in household waste for incineration. Recycling probably demands them to sort out the waste in different fractions and in addition to that, for most people transportation of packages to the nearest waste collection is needed. This might make them throw it in the regular bin instead. Some people might not be aware that soft plastics can be sorted with hard plastics and then recycled since this has been possible only the last five years (VA SYD, 2012 a). Whatever the reason for not recycling the bread packaging might be results are not surprising when compared to studies by Karlsvärd *et al.* (2008) and Fredriksen *et al*. (2010). Both of them report that household waste analyses showed that more than 50 % of the bread was found in its original packaging. A lot of consumers don't recycle bread packaging – thus, a lot of bread packaging ends up in the ordinary household waste, frequently containing the bread it was sold with. This also means that bread waste will be incinerated and not go into the food waste bin for methane production. A this point 60 % of Swedish municipalities provide separate food waste collection (Svenskt avfall, 2012) and the number is increasing. This should mean more and more consumers get aware of the possibility to separate the bread and packaging going to waste. Thus, the amount of packaging ending up in "wrong place" (meaning incineration instead of being recycled) might be reduced when more households have to separate their food waste from the rest of the waste. When the bread is removed from its packaging and thrown in the food waste, consumers might be reminded that the packaging also have its special place in the waste system.

Question 7: Which of the following packaging features would possibly make you throw away less bread?

Question 7 provides suggestions of packaging features and asks if one or several of these would make the consumer waste less bread. It is a highly hypothetical question but can be used to show if any of these alternatives seem to be of interest

from the consumers' point of view. Respondents were allowed to choose more than one alternative if they liked to. Figure 20 presents results from Question 7. It can be seen that varying packaging sizes was thought to reduce the wastage by 44 % of all consumers, followed by the suggestion to have small portion packages inside a larger packaging, 22 %.

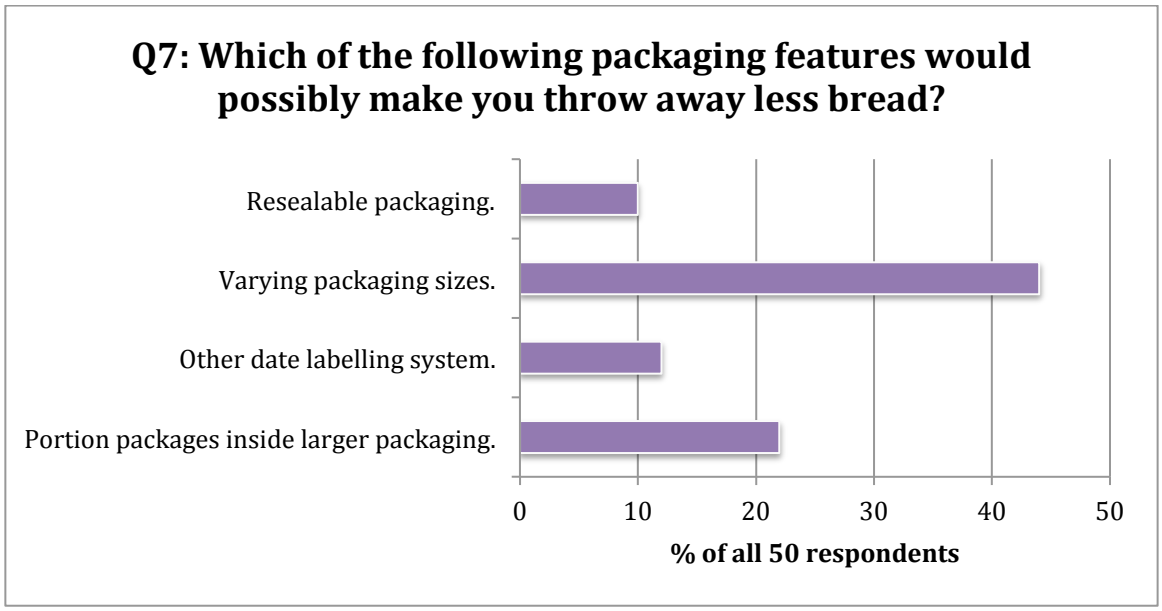

Figure 20. Answers to Question 7, each staple represents the number of respondents choosing each alternative.

Varying packaging sizes was the alternative receiving far most votes on what packaging features that might make consumers waste less bread. Together with responses on previous questions, this concludes that consumers regard the packaging sizes as a problem. Too large packages is the most common underlying reason for people to waste bread and a more varying range of sizes could make them waste less bread (at least out of the options provided in this survey). It would be in line with these results to think that if large packages were a problem, single households would waste more than larger ones due to their incapability to finish the bread before it gets uneatable. Three out of nine single households participating in this study thought varying packaging sizes would help them waste less bread. Results from the question regarding how much bread different households waste are not really showing if small or large households waste most. Thus, it is somewhat hard to draw any conclusions whether packaging sizes really affect the waste amount. At least consumers have a clear picture that it does. This might be enough to say that more varying packaging could help reducing the amount of wasted bread.

The suggestion to have portion packages with bread in a larger packaging to enable the possibility to open just a few slices at the time and ease freezing of some portions was thought to reduce waste by 22 % of the respondents. This packaging feature does require more material than the other solutions, but as Williams and Wikström (2011) conclude, this environmental strain can be compensated for if the amount of bread waste is reduced. Portion packages were further thought to go in line with the development of "grab and go" products as was discussed by packaging managers at bread-producing companies.

Only 12 % of consumers thought another date labeling system would make them waste less bread. It might be hard for consumers to imagine how another system would look and how this would affect their behavior. Maybe one has to try out a new system in real life to know whether it will work or not. This low number together with results from Question 5 (30 % of consumers don't look at the date labeling when judging whether to eat bread) suggests that when it comes to bread, date labeling might not have that crucial role as the Consumer Association of Stockholm (2009) suggests for food in general. However, the date labeling system affects the amount of waste in more ways that weren't examined here. For example, consumers picking bread with baking day today or yesterday leaves some bread on shelves in stores and thus directly impact waste in terms of returns from retailer to producer. However, the amounts wasted by consumers in their homes might not be influenced by the date labeling system to the degree as was expected.

Only 10 % thought resealable packaging would make them waste less bread. This implies that most consumers are satisfied with the sealing mechanism used today - at least they don't connect this to the amount of bread they waste.

4.3.4 Statements Concerning Environmental Impact

Cox and Downing (2007) formulated, among other things, two statements when performing a consumer study in the UK. It was considered interesting to compare results from the UK market with Swedish consumers. Thus these two statements were used in this consumer survey as well. To answer the statements respondents were asked to reply whether they disagreed or agreed on a scale from one to five. 1 = Strongly disagree, 2 = Tend to disagree, 3 = Neither agree nor agree, 4 = Tend to agree and 5 = Strongly agree. One difference from previous sections is that Figure 21 and Figure 22 also presents results from the British study by Cox and Downing (2007) to ease comparison of results.

Question 8: To what extent do you agree or disagree with the following statement? - Discarded food packaging is a greater environmental issue than food thrown away.

Question 8 is a statement that examine consumers' picture of how packaging waste affects the environment compared to the environmental effect of food waste. It is a very generalized statement and does not explain what packaging and what type of food – the ratio of environmental impact between these two varies of course. Anyway, it can provide some information of consumers´ general attitude towards packaging.

As is presented in Figure 21 answers were spread quite even on the agree- and disagree end of the scale. 38 % of respondents disagreed and 46 % agreed with the statement.

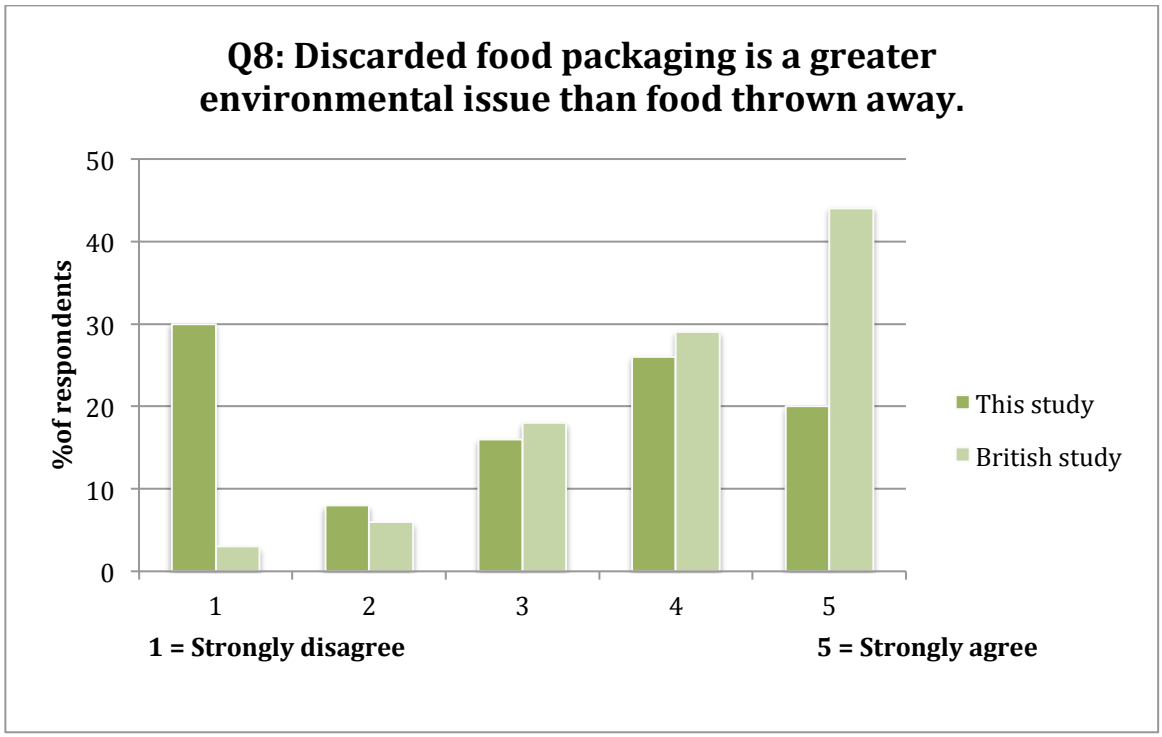

Figure 21. Answers to Question 8. Respondents were asked to relate to a statement on a scale from 1 (Strongly disagree) to 5 (Strongly agree). Results from this study presented in darker green staples and results from Cox and Downing (2007) presented in brighter staples.

Results show that Swedish consumers are not much more sensitive towards packaging than food waste. Only a few percentages more agree than disagree, and the amount that strongly disagrees to this statement is the largest group.

Compared to results from Cox and Downing (2007) answer frequencies are really different when it comes to the "strongly agree" and "strongly disagree". Also, in the British study only 9 % disagreed with the statement and as much as 73 % agreed. This shows that British and Swedish consumers have somewhat different attitudes towards packaging. Six years have gone since the British study was performed; maybe results would have been different if the study was performed once again today. After all, recent years have highlighted food waste, packaging and environmental impact of our consumption and, hopefully, changed the attitude of some consumers.

What can be said is that in this study a higher number of respondents were confident to say they strongly disagreed than those stating they strongly agreed. This might be since consumers with higher degree of consciousness, when it comes to how their own consumption affects the environment, also feel more confident when responding to this kinds of questions. Meaning more people disagreeing are confident saying they strongly disagree than those agreeing.

Those who strongly disagreed threw away packed bread in a moderate amount to a higher degree (29 %) than those who strongly agreed (8 %). Otherwise it was hard to draw any conclusions between Question 8 and how much bread people waste.

When compared with Question 6 concerning recycling of bread packaging, it could be concluded that 70 % of those who strongly agreed on the Question 8-statement never or seldom recycle bread packaging. The corresponding number for those who strongly disagreed was only 33 %. Thus, it might be that people who are not really interested in these kinds of questions don't recycle and they also tend to have the picture of the packaging as more hazardous than food waste. Maybe because they haven't thought of the impact of food losses or realized that a lot of inputs utilized to produce the food are wasted when the food is thrown away. It might be that people who strongly agree on this statement also will agree on the following Question 9.

Question 9: To what extent do you agree or disagree with the following statement? - Food thrown away is not an issue since it is natural and biodegradable.

Question 9 is a statement that examines consumers' general attitude towards food waste. Do they consider that a lot of energy is put into the food supply chain, and thus to no use if the food is thrown away? Figure 22 presents results from Question 9. A higher number of consumers (48 %) disagreed with the statement than agreed (36 %).

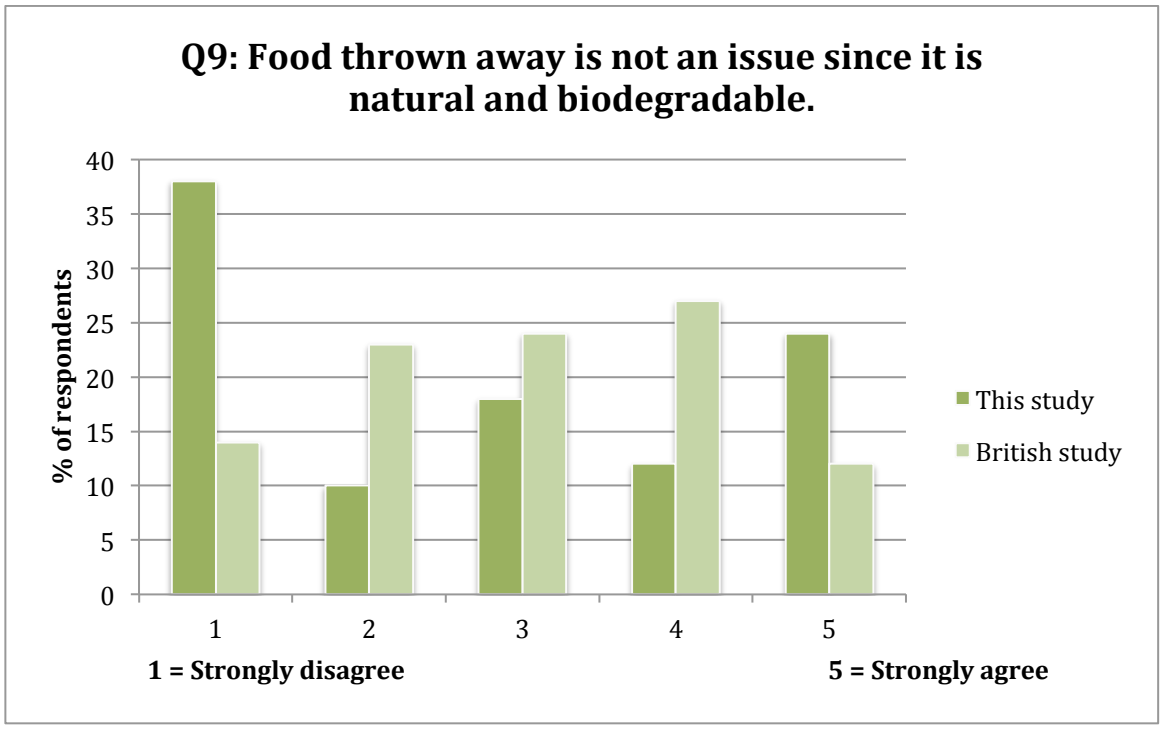

Figure 22. Answers to Question 9. Respondents were asked to relate to a statement on a scale from 1 (Strongly disagree) to 5 (Strongly agree). Results from this study presented in darker green staples and results from Cox and Downing (2007) presented in brighter staples.

More consumers disagreed than agreed with this statement. It is a good thing that most consumers realize food waste is an issue, but one can only hope that more and more people get aware of this. It is kind of worrying that such a large proportion of consumers (36 %) believe food waste does not have any environmental impact.

Compared with the British study by Cox and Downing (2007), where 37 % disagreed and 39 % agreed, results are in general more similar to this study compared with the first statement. It can be noted though that the amount that strongly disagreed with this statement was 38 % in the Swedish study and only 14 % in the British. Swedish consumers tended to state they strongly agreed or disagreed to a higher degree than British who more often placed themselves in the middle (2,3 or 4) on the scale.

Comparison of peoples' answers on Question 8 and 9 gave the answer frequencies for the most common combinations; they are presented in Table 14.

Table 14. Most common combination of answers on Question 8 and 9, from 1 = strongly disagree to 5 = strongly agree.

Answers on Question 8 + Question 9	Number of Respondents
1+1	10
5+5	6
4+3	5
4+4	4
4+1	4

Table 14 shows that 20 % of participating consumers strongly disagreed with both statements and that this combination of answers was the most common one. Thus, people who thought packaging is not a larger hazard for the environment many times also realized that wasted food is a waste of resources that is an issue – even though food is biodegradable.

4.3.5 Summary – Consumers

It can be concluded that consumers waste a large fraction of bread, even though this study not made it possible to estimate any amounts to compare with production and retail. The consumer questionnaire showed packed bread is bought twice as much as unpacked bread. Packed bread is thrown away to a somewhat higher level than unpacked and men tend to waste a little more than women. Further, consumers under 25 and over 70 years only waste minor amounts of packed bread and the high-wasters of both packed and unpacked bread seem to be in the age of 41-55 years. The most common reason for consumers to waste bread was because it looked bad (45 %). It was somewhat hard to conclude how household size affected wastage of packed bread since single households wasted less than households with two and four people but more than those with three and five people. It might basically be easier to plan your consumption if you are alone, even if packaging sizes really are inappropriate for single households. With regard to unpacked bread it can however be concluded that single households waste more than larger households. This suggests that it is hard for people living alone to buy unpacked bread in a size that suits their consumption patterns.

It was clear from the questionnaires that consumers addressed the main reason for why they throw away bread to the size of the bread packaging. Smaller packages were said to be able to help them to waste less bread. The question is whether a smaller packaging really would help in practice. At least, consumers have a clear picture that it would. This might be enough to say that more varying packaging sizes could help reducing the amount of wasted bread. On the other hand, a smaller packaging would probably have a higher price per weight and one can wonder how many consumers are willing to pay a higher price per piece of bread in order to reduce their own wasting.

This study showed that Swedish consumer might not be that sensitive to date labels on bread as British consumers showed to be in earlier studies. 28 % replied they don't eat bread past its date label compared to 56 % in the British study. This was reinforced by a less fraction of respondents in the Swedish study, compared to the British, claiming the main reason for them to throw away bread was that it had passed its date. Instead the main reason given by Swedish consumers was that the bread looked bad. The survey did however not examine the interpretation of date labels or how consumers rank the importance of baking day and best before. It can only be concluded that some people make their consumption choices based on the date labels and further investigations will have to show whether a change in date labeling system can help reducing the amount of waste.

It was further concluded that it seems like consumers who are not really interested in these kinds of environmental questions don't recycle and they also tend to have the picture of the packaging as more hazardous than food waste. Overall though, the majority of consumers in this study disagreed with the statement that food waste not is an issue since food is biodegradable. Finally, it was concluded that a large fraction of consumers never or seldom recycle the bread packaging today. The ongoing implementation of food waste separation might however have the power to impact the recycling of packaging as well. When the bread is removed from its packaging and thrown in the food waste, consumers might be reminded that the packaging also has its special place in the waste system.

5. Conclusions

The overall impression received during this work was that bread waste is not regarded as an issue, especially not among retailers. Further, it seems to be more of an economical than environmental aspect when actors think about the impact of bread waste. Thus, the question is how much effort different actors are willing to put in to reduce the amount of wasted bread. In the end though, everything seems to depend on the behavior of consumers. Producers and retailers will have to focus their actions towards making consumers more aware of the environmental effects of their choices and help them act in a way that reduces the amount of waste, both in households and retail stores. To do this they might need help from higher levels like the National Food Agency.

No one in this study thought the packaging could be directly related to the formation of bread waste. Nevertheless, actors in all three steps – production, retail and consumption, suggested different packaging aspects that could be useful for bread waste reduction. They were not totally in consensus about the impact individual aspects might have. It was however discussed that a wider range of packaging sizes could provide packages suitable for all household sizes and increase flexibility and this might decrease the waste in households. The question is whether consumers are willing to pay a higher price to waste less, since smaller packages today usually cost more per weight than larger ones. Further, the current date labeling system might not be interpreted as desired. In addition to this baking day might be a large waste creator in retail stores. Thus an investigation of current dating systems, how they are interpreted and prioritized might help to reduce some waste, both in households and retail stores. The question here is whether consumers are willing to buy bread without baking day label – not knowing when the bread was produced.

This thesis has identified aspects both in relation to the packaging and other measures, which can be connected to bread waste formation - like for example ordering routines, importance of having access to cashier information and a shared responsibility for return waste. It seems like, as in other food sectors in the developed world, the largest fraction of bread waste is formed at retail and consumer levels. Thus, this is also where the largest potential for improvement lies. It might need competitors along the FSC to co-operate with regard to waste reduction, as it seems like some of the waste is created due to the normal competitive market mechanism. All actors along the FSC will need to be aware of aspects that form bread waste and have the will to co-operate in order to get a result. As mentioned above it might be required to implement changes that some parties are not totally satisfied with in order to achieve a collective goal.

The next step will be to use findings in this study together with information in other literature in an attempt to optimize the design of bread packaging systems, and in this way reduce the amount of wasted bread.

6. Future Aspects

During this thesis work information has been obtained making it possible to identify possible improvements and issues that acquire further examination. Here follows a list, suggesting improvements and future work:

Improvements

- Throughout the thesis work, a greater experience in planning and performance of interviews would have made it easier to question information given by experts. Especially when contradictive answers were given. This would have made it easier to sort things out and find more straight-through connections between packaging aspects and waste formation and thus ease the work of conclusion making.
- As was mentioned in the methodology, it would be desirable to send back information from expert interviews to respondents for a reliability control.
- It would be advantageous to include more consumers in the questionnaire survey to get statistically significant results.
- It would be interesting to perform the same kind of expert interview with salesmen having the responsibility of placing orders.
- Since consumers were asked about their packaging recycling habits, it would also be interesting to ask them what they do with bread they throw away.

Future work

- Find out why not all producers receive information from retailers' cashier systems.
- Find out what is the main reason for different bread producers having varying return rates.
- Perform a life-cycle assessment analysis on the two commonly used secondary packaging systems; plastic boxes or corrugated board boxes, and evaluate what system is most environmental friendly to use.
- Perform a consumer survey of the interpretation and importance of different date labels (best before and baking day) on bread.

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Appendix 1 – Producer Interview

1. Introduction

Company: Date:

- Name
- Title
- Working tasks
- Experience in the field
- Educational background.

2. Production to Retail

- What kind of bread does your company produce?
- How much bread do you produce?
- To whom do you produce?
- What kind of information do you utilize to estimate how much bread to produce?
- Do you produce as much as you predict you will sell or more than that? How much more?
- How much does your bread cost compare to others?
- For how long does it keep?
- Who orders the bread?
- Who delivers your bread?

3. Bread Waste

Formation of waste

- Do you know how much bread you waste in the production? How much do you waste?
- Where does waste appear? What are the reasons? Difference between packed/unpacked bread?

Prevention of waste formation

- Do you work actively to decrease the amount of waste? How?

Waste handling

- What happens to the waste from production, any difference between packaged and unpackaged products?
- How is packed bread unpacked?

Waste in later steps of food supply chain

- Which step wastes most?
- Do you have methods to collect information about waste in later steps, like retail stores? How do they work?
- How much bread is returned from retail?
- Who takes financial responsibility for the waste? Does it depend on where in the chain waste appear?

- Does your clients have the right to return un-sold products?
- What happens to waste from retail stores?
- How long is your bread allowed to lie on shelves in stores?

Consumer contact

- Do you communicate with your consumers about waste of bread?
- Do you think consumers consider waste of bread as a problem?
- Do you know what consumers state as the main reason they waste bread?

Future measures

- One action proposed to reduce the waste has been to inform the personnel about the environmental impact of food waste. Have you done such thing? Do you think it would have any effect?
- Have you plans on how to reduce the waste in the future?

4. Packaging

Current packaging system

- If they produce both packed and unpacked: Why are some bread sold packed and others unpacked?
- What does the packaging systems look like today?
- Why does the packaging system look like that? Have any other system been evaluated?
- Are there a lot of packaging options to choose from?
- What do you see as the main functions of the packaging?
- Who decides the performance of the packaging?
- How does your date-labeling system work?
- What du you think about “At least preservable until”?

Packaging role in prevention of waste

- Do you think a different packaging would be able to prevent the formation of waste in the production?
- To what degree do you think that the waste can be related to the packaging today?
- What do you think about the statement made by Williams et al; an optimized packaging can reduce the total environmental impact from the food-packaging system, even if the impact from the packaging itself is increased, through decreasing the final amount of food wasted.
- Smaller households have claimed they have a hard time consuming all bread when the packages are too large. They are not able to finish the bread in time. Do you think smaller packages would help reducing the amount of waste?

Consumer contact

- What kind of contact do you have with your consumers regarding your packages?
- Is it hard for you in the industry to catch consumers’ interests and thoughts about for instance packaging since you are located early in the food supply chain and they are in the end?

- Would a change in packaging performance, like smaller units or a new date labeling system coming from consumer surveys, be a problem for the producer?
- Do you consider the waste by consumer as a part of your responsibility? Do you feel you can have impact on the wastage with the packaging?
- What do you think can make consumers waste less bread? In relation to the packaging?

Development

- Do you work with optimization of existing packaging or mostly with development of new packages for new products?
- How do you think future packaging systems will differ from those used today?

5. Finish

- What do you consider as the main issue in wastage of bread, seen to the whole food supply chain from production to end-consumer? Can you as a packaging developer do something to improve this?

Appendix 2 – Retail Interview

Store and date of interview:

1. Introduction

- Name
- Title
- Experience in the field
- Education.
- What types of bread does your retail store offer?

2. Bread Waste

Relation with producers

- Who takes financial responsibility for bread that is not sold?
- What kind of contract is there between producers and retail?
- How do you think this system works?
- How come you have this contract with bread producers? Does it exist with other products? Which ones?
- Have you always had this contract on bread?
- Are you aware of how much bread that is sent back in return to the producers?
- How do you think the amount of wasted bread would change if you hadn't full rights of return?
- What would the consequences be for you if full rights of return didn't exist?
- Do you have the possibility to order small amounts of different items at this point?
- Do producers receive information about selling rates etc. from your cash systems?
- How would you describe your relationship with bread-producing companies?
- Is there something you would like to change in the relation with producers?
- How do you think the contract affects producers?
- Do you have any ideas on how producers could reduce the waste (return rates) from retail?

Ordering of bread

- Who orders the bread? Does this affect how much bread that is wasted?
- How large part of the problem with bread waste is made up of issues with ordering the right amounts?

Formation of waste

- How much bread do you throw away/take back from the shelves in the store?
- Where does bread waste appear at retail level and what are the reasons?
- How could you as retailers possibly affect wasted amounts of bread?
- Do you lower the price on bread that begins to reach its best before date?
- If consumers are the main issue – could you do something in an attempt to try to change their behavior?
- Who decides for how long bread is allowed to lie on shelves?

- Do you think the handling by personnel in stores affects the amount of waste?
- Do you consider the wastage of bread an issue?
- Do you think you have any responsibility in decreasing the amount of wasted bread?

Consumers and promotion in store

- What kind of dialogue do you have with your consumers about their requirements regarding bread range?
- Do you think it would be possible to reduce the amount of unpacked bread waste in stores simply by providing consumers with a fewer varieties of bread later in the day?
- One Nordic study states that consumers are expecting full shelves, and in order for retail stores to meet these expectations they have to overproduce fresh baked bread – often 7 % more than expected sales are produced. Do you recognize this in your shop?
- Best before dates long = last for long time = less food will be wasted, but! Consumers want to buy fresh food and are suspicious to food with too long date (additives etc.) the trend goes for shorter and shorter shelf lives. Have you noticed this trend?

Waste handling

- What happens to the waste, any difference between packaged and unpackaged products?
- Considered other optional waste handling methods? (Kitchen in store or food-bank (Allwin)?)

Future measures

- Are there any goals set on reducing the amount of bread waste?

3. Packaging

Packaging system of bread

- What do you think of the packaging systems used for bread today?
- Is there anything you, as retailer would like to change?
- Do you think that the packaging for transport, plastic wrapping, cartons and pallets have gained a lower quality lately?
- To what degree would you say the waste in retail is related to the packaging? (Information, size, date label, ease of emptying etc.)
- Do you think a different packaging system would be more efficient preventing the formation of waste at the retail step? If so, how? How would that system be designed?
- How would a change in packaging performance, e.g. smaller size, a new date labeling system or something else that is based on requests from consumer surveys, affect retail?

Future measures

- Is there any on-going discussion with the suppliers etc. on a change in the packaging systems?

- How do you think the future packaging systems will differ from those used today?

4. Finish

- What would you say is the main problem that creates bread waste at retail level?
- What would be needed to do in order to reduce the amount of wasted bread in retail?

Appendix 3 – Consumer Questionnaire

Introduction

Retail store

- COOP
- ICA
- Green Matmarknad
- City Gross
- Willys

Gender

- Female
- Male

Age

- <25
- 26-40
- 41-55
- 56-70
- >70

Number of people in household

- 1
- 2
- 3
- 4
- 5
- >5

Bread Waste

1. How much packed bread do you buy?
   - Nothing
   - 1 loaf/month
   - 1 loaf every second week
   - 1 loaf/week
   - 2 loafs/week
   - 3 loafs/week
   - More than 3 loafs/week

2. How much unpacked bread do you buy?
   - Nothing
   - 1 loaf/month
   - 1 loaf every second week
   - 1 loaf/week
   - 2 loafs/week
   - 3 loafs/week
   - More than 3 loafs/week

3. How much packed bread do you waste?
    - Quite a lot
    - A reasonable amount
    - Some
    - A little
    - Hardly any
    - None

4. How much unpacked bread do you waste?
    - Quite a lot
    - A reasonable amount
    - Some
    - A little
    - Hardly any
    - None

5. What is the most common reason for you to throw away bread?
    - Past best before date
    - Looked bad
    - Bread went moldy
    - Plate leftover
    - Other (inedible)
    - Smelt/tasted bad
    - I don't waste bread

6. Of the following, what would you say is the most common underlying reason for you to throw bread?
    - The bread was already a few days from baking day when purchased.
    - Too large bread packaging.
    - Wrong storage at home (plastic bag not resealed etc.).
    - Poor quality of the bread.
    - I don´t waste bread.

7. Thinking about how you use the dates on the labels of bread, which of the following statements best describes you?
    - I never eat past the date on the label.
    - I occasionally eat past the date on the label.
    - I often eat past the date on the label.
    - I don't look at the date on the label.
    - I don't eat bread.
    - I don't know.

Packaging

8. To what extent do you recycle the bread packaging?
    - Never
    - Seldom
    - Sometimes
    - Often
    - Always

9. To what extent do you agree or disagree with the following statements…?

    - Discarded food packaging is a greater environmental issue than food thrown away.

      Strongly disagree Strongly agree
      1 2 3 4 5

    - Food thrown away is not an issue since it is natural and biodegradable.

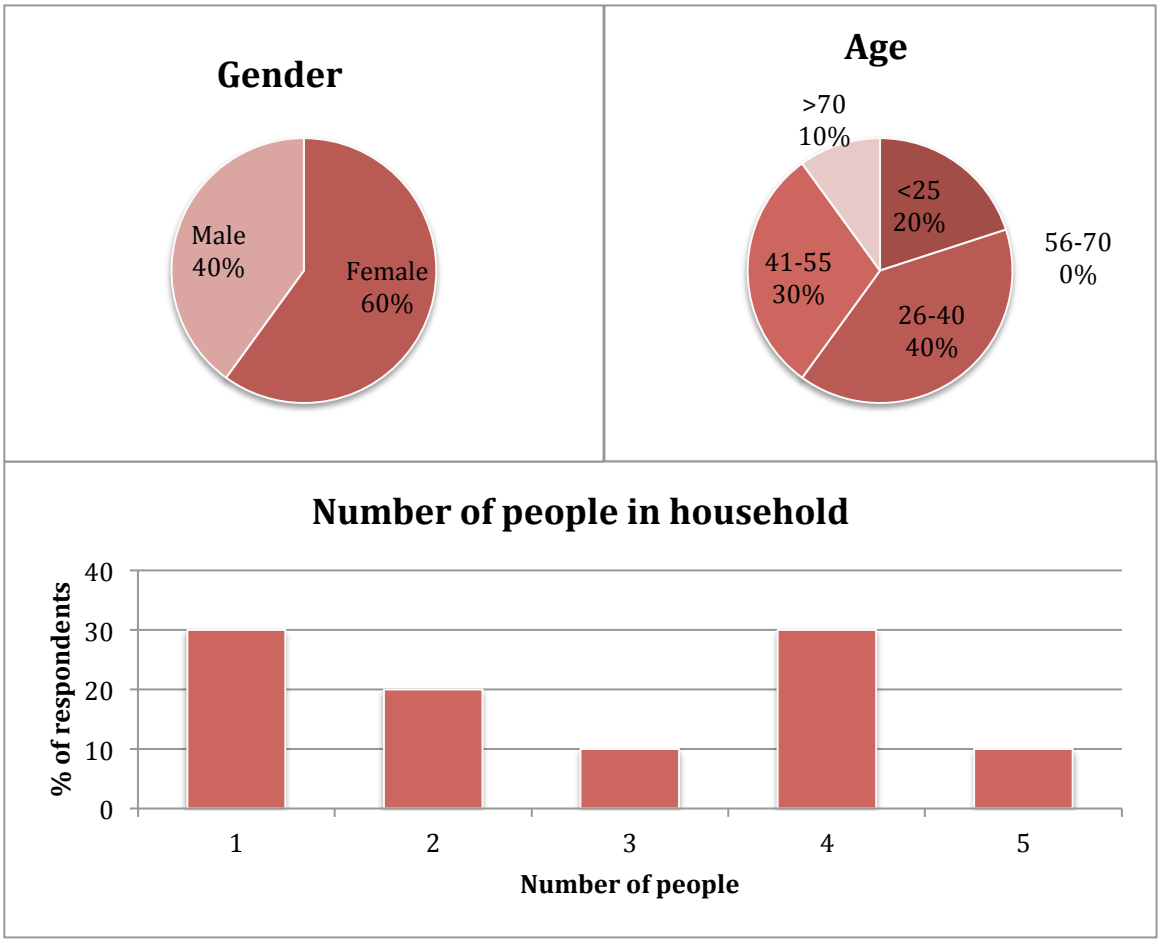
      Strongly disagree Strongly agree
      1 2 3 4 5

10. Which of the following packaging features would possibly make you throw away less bread?
    - Resealable packaging e.g. with zip.
    - Varying packaging sizes.
    - Other date labeling system, like “at least preservable until” or biosensors.
    - Portion packages inside big package.

Thank you for participating!

Appendix 4 – Socio-Demographic Factors for Respondents in each Retail Store

Willys Katrinelund



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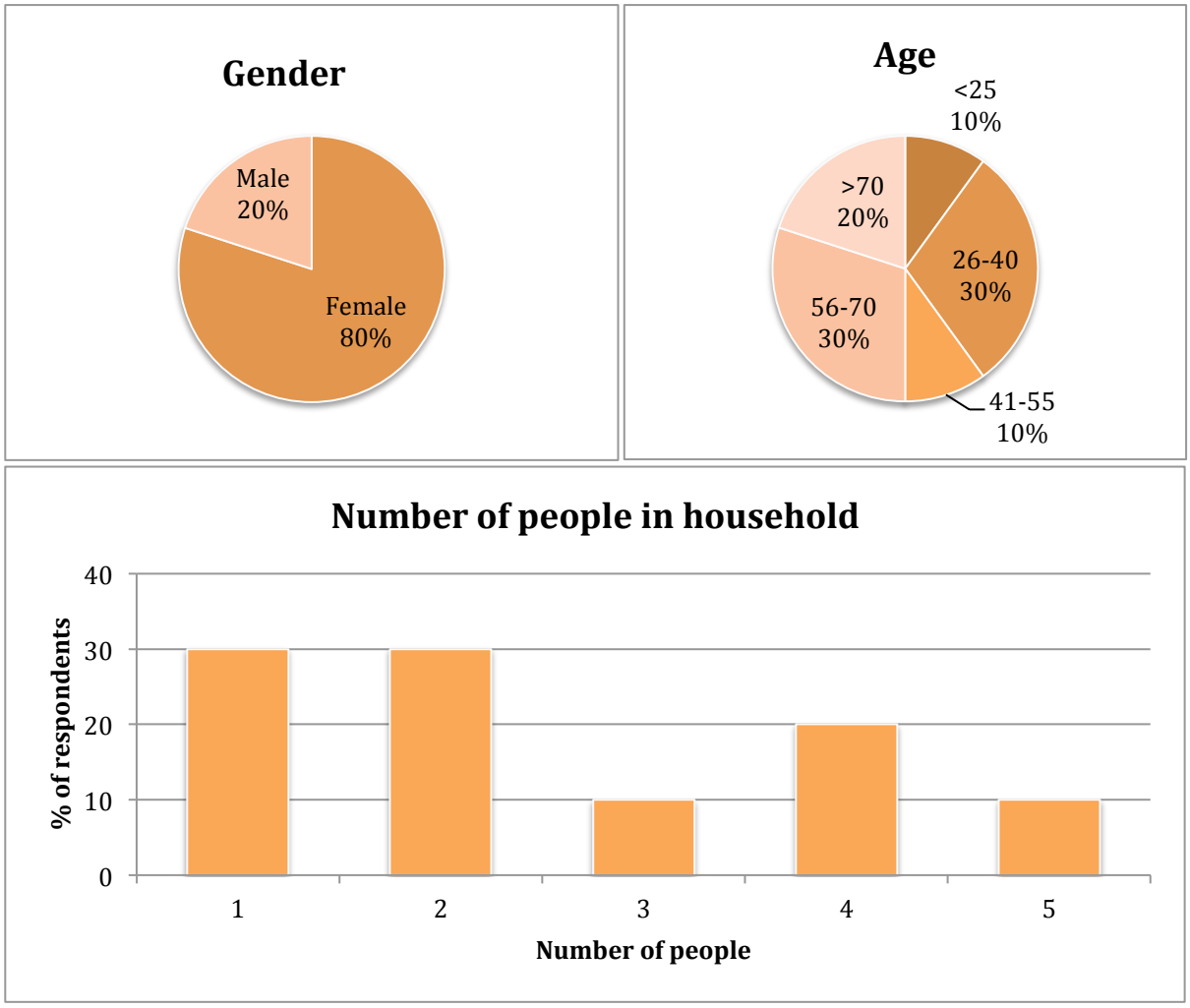

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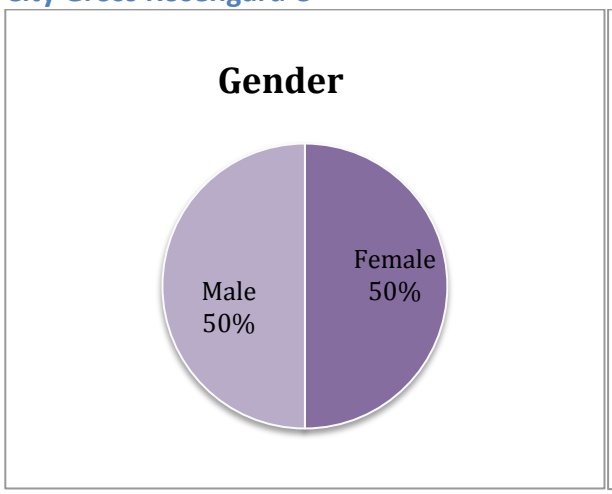

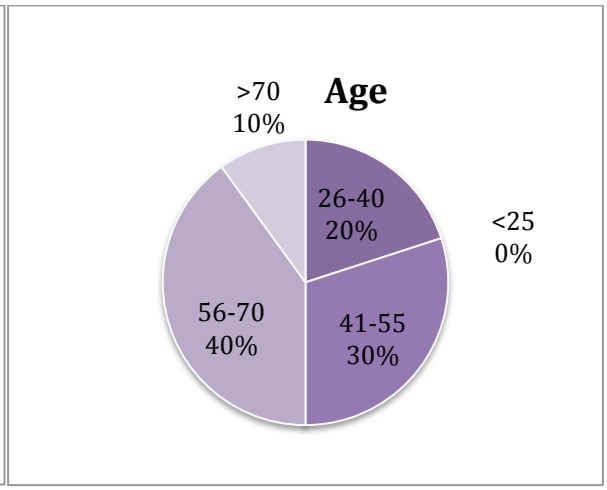

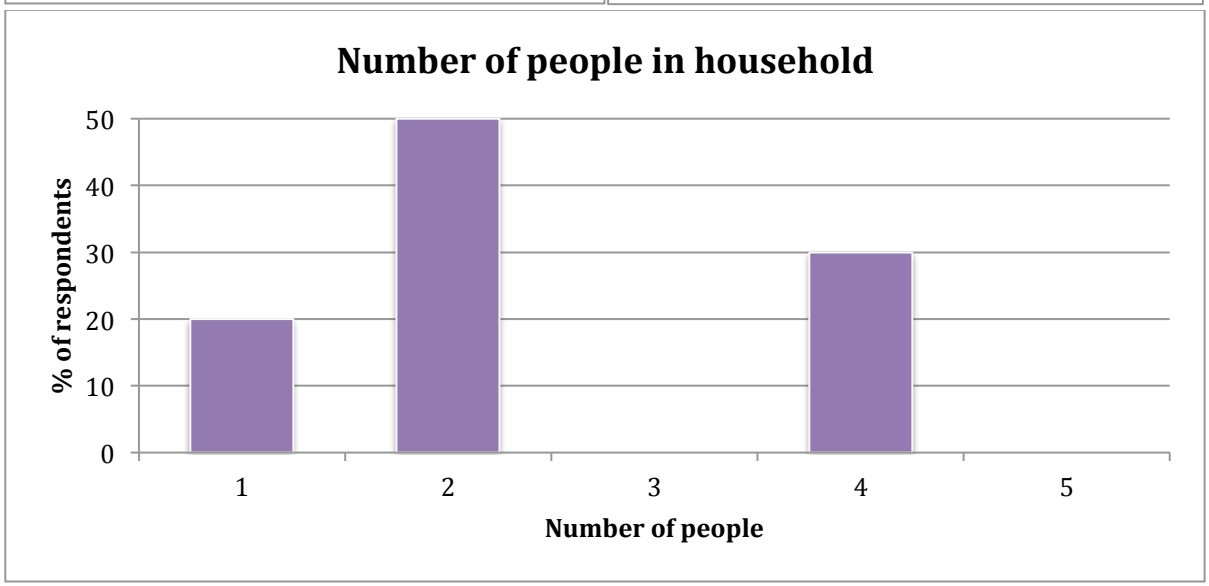

Coop Konsum Norra Parkgatan

Green Matmarknad Västra Hamnen