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Evidence on the Role of Supplier-retailer Trading Relationships and Practices in Waste Generation in the Food Chain

Carlos Mena
Portland State University

Peter Whitehead
IGD

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Contacts:

Carlos Mena
Supply Chain Research Centre
Cranfield School of Management
Cranfield, Bedfordshire, MK43 0AL
t.+44(0)1234 751122
f.+44(0)1234 751712
carlos.mena@cranfield.ac.uk
www.cranfield.ac.uk

Peter Whitehead
Agri-business Programme Leader
IGD, Grange Lane, Letchmore Heath,
Hertfordshire, WD25 8GD, UK
t. +44 1923 851920
f. +44 1923 852531
Peter.Whitehead@igd.com
www.igd.com

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1. Executive Summary

Waste is a significant problem for the UK food and drinks supply chain. It has been estimated that the industry produces about a third of all industrial and commercial waste in the UK and volume figures range between 18 – 20 million tonnes of waste per annum. In 2006, the Food Industry Sustainability Strategy (FISS) decided to address the waste problem and presented the industry with a major challenge: "to reduce the amount of food and packaging waste that is produced each year… and to recycle or otherwise gain value from the waste that does arise" (Defra, 2006: 37). The FISS also suggested a target of reducing waste by 15-20% by 2010. Furthermore, a recent consultation by (BBSRC, 2009) has highlighted waste reduction as a major challenge for food security.

The government has made significant investments in best practice programmes such as WRAP and Envirowise to help industry reduce waste. These programmes have made good progress, however, an area that has so far been neglected is the waste generated in the interface between retailers and their suppliers. Waste generated at this stage has important financial and environmental implications because products have already gone through most of their value adding activities, accumulating costs and embedded energy.

This project aimed to address the problem of waste at the supplier – retailer interface in the UK food chain. More specifically the objectives of the project were:

1. To assess the prevalence and magnitude of food and packaging waste in the supplier / retailer interface.
2. To identify the main root causes of waste
3. To identify good practices and examine the enablers and inhibitors to their implementation
4. To provide recommendations for policy and practice that will help the food and retail industries to jointly address the root causes of waste.

To achieve these objectives a case study methodology was used, looking at a range of products with different characteristics of temperature regime (ambient, chilled and frozen) and shelf-life (short, medium and long). Initially we agreed to conduct 16 case studies, although this was expanded to 20 in order to explore in more detail issues related to chilled products. The cases were divided into two waves; the first wave of 10 cases focused on estimating the magnitude of the problem and identifying the root causes of waste. The second wave focused on identifying good practices in waste management.

The research indicates that average waste generated between suppliers and retailers ranges between 0.1% and 10%. Out of the 20 cases, ten had waste figures below 3% and only one had figures exceeding 7%. However we found that in extreme cases, during short periods, waste for some products could be as high as 30%. Nevertheless it is possible to conclude that waste levels between food manufacturers and retailers are considerably lower to those reported by Wrap (2008) on household waste which amount to one third of all purchases.

The majority of products with high and very-high waste are products with short shelf-lives (less than two weeks) such as meat, fruits and vegetables. Similarly the majority of products with long shelf-lives (more than two months), such as ice cream, pasta sauces and beverages tend to have very low levels of waste. However, it is important to note that not all products with short shelf-lives have high levels of waste, several products such as milk, cooked poultry and potatoes have levels of waste lower than 3%. These products however, have relatively stable demand patterns throughout the year, as they are not substantially affected by factors, like seasonality, weather and promotions. This is an important finding because it shows that the causes are dependent. This is, it is not the short shelf-life of the product or the demand variability that cause the waste, but the combination of the two. This makes it impossible to attribute specific figures of waste to either of these causes.

The analysis of root-causes led to the identification of the groups of issues affecting waste:

- Mega-trends: these are consumer and industry trends that affect the problem of waste such as increasing demand for fresh products and products out of seasons, as well as a move away from products with preservatives. These are important factors affecting the waste problem, but the impact that company strategies and processes have on them is limited.
- Natural constraints: these are factors associated with the nature of the products and processes that can affect waste. Issues like short shelf-lives of fresh products, seasonality of supply and demand, weather fluctuations and longer lead-times for imported products are among these factors. Similarly to the megatrends, the impact of business practices on these issues is limited.
- Management root-causes: these are factors affecting waste on which management practices have a direct impact. We believe these are the root-causes that are worth exploring in detail, since it is by changing these issues that organisations will be able to reduce waste. The nine causes identified are: Waste management responsibilities, information sharing, promotions management, forecasting, performance measurement, packaging, cold chain management, quality management and training.

Not all companies deal with the management root-causes in the same way and through the case studies it was possible to identify good practices to deal with each of the causes. These good practices can then be translated into recommendations for industry. Ten specific recommendations for food producers and retailers were identified in the research and are discussed in detail in the scientific report. These are:

- To ensure there is accountability for waste
- To promote a culture of waste reduction
- To embark in collaborative activities to improve information flows and decrease waste

- To analyse promotions more closely and consider their impact on waste
- To have an analytic approach to forecasting
- To manage process efficiently and effectively to reduce waste at all stages
- To maintain the cold chain management
- To consider the natural characteristics of the product
- To use packaging effectively and responsibly to protect the product and extend its life
- To follow the "Reduce, Reuse, Recycle" logic to prevent waste to landfill

Waste reduction should be a priority for organisations in the food industry, not only because waste represents an economic loss for the companies involved, but also because of its environmental implications. Nevertheless, there are some areas for further research and dissemination . These are:

- Continual and systematic data collection on waste, particularly figures on waste to landfill, which will support benchmarking and allow trend analysis.
- Dissemination to make industry more aware of the scale and impact of the problem, by conducting research and disseminate good practices
- To support research and technology transfer in areas such as cold chain technologies, packaging technologies, shelf life extension, and anaerobic digestion
- To investigate approaches to incentivise alternatives to landfill such as the use charities or the generation of energy from waste

2. Introduction

2.1. Scope and Objectives

This report presents the results of the project entitled "Evidence on the role of supplier-retailer trading relationships and practices in waste generation in the food chain" commission by Defra (Project Code SFFSD0705) and undertaken by Cranfield University and IGD between July 2008 and June 2009.

The overall aim of the project was to provide a qualitative analysis of the food and packaging waste arising from the link between food manufacturers and retailers in the UK. The specific objectives of the project were:

- To identify the root causes of waste between suppliers and retailers in the UK
- To assess the magnitude of each root cause
- To identify good practices and examine the enablers and inhibitors of their implementation
- To provide recommendations at a company and government level that will help the food and retail industries to jointly address the root causes of waste

The study had a UK perspective and it focused on the relationship between food retailers and their suppliers, and how their business processes and practices affect waste. Waste of finished products, discarded by producers, wholesalers, hauliers or retailers was the primary focus, and waste arising during production and agricultural processes was excluded from the study. However, during the project we collected additional information concerning other stages of the chain and other countries, which we have used for comparative purposes.

2.2. Food and packaging waste: Framing the problem

Waste can be defined in a number of ways. For instance the OECD/Eurostat (2005) uses the following definition: "*Waste refers here to materials that are not prime products (i.e. products produced for the market) for which the generator has no further use for his own purpose of production, transformation or consumption, and which he discards, or intends or is required to discard. Waste may be generated during the extraction of raw materials during the processing of raw materials to intermediate and final products, during the consumption of final products, and during any other human activity*."

For this project we decided to follow the more concise definition from the EU Council Directive, which defines waste as *"any substance or object the holder discards, intends to discard or is required to discard"* (EU, 1991). This will include all facets of physical waste including produce and packaging. Not included in this project will be the study of wasted time, energy and resources. This compares with other definitions of waste that often include products that are under sold, recycled back into production or waste arising from process inefficiencies.

Waste is recognised as a major issue by the retail, food and packaging industries in the UK. In 2005, major retailers and producers signed a voluntary agreement with Defra and WRAP aimed at reducing packaging and food waste. This agreement, known as the Courtauld Commitment, covers 39 major retailers, brands and suppliers, and represents 92% of grocery supermarkets (WRAP, 2008; 2009). A year

later, the Food Industry Sustainability Strategy (FISS) presented the industry with the challenge of *"reducing the amount of food and packaging waste that is produced each year… without compromising food safety; and to recycle or otherwise gain value from the waste that does arise"* (Defra, 2006).

The UK government has made significant investment in best practice programmes such as the Waste Resources Action Programme (WRAP) and Envirowise to help the industry reduce waste and meet the targets set by FISS. These programmes have made good progress in various areas of waste minimisation such as packaging, manufacturing and home waste. However, an area that has so far been neglected is the waste generated between the production and retail stages. Waste at these stages has important financial and environmental implications because products have already gone through most of their value adding activities, accumulating costs and embedded energy. Therefore, reducing waste at this stage would not only cut costs but also reduce emissions.

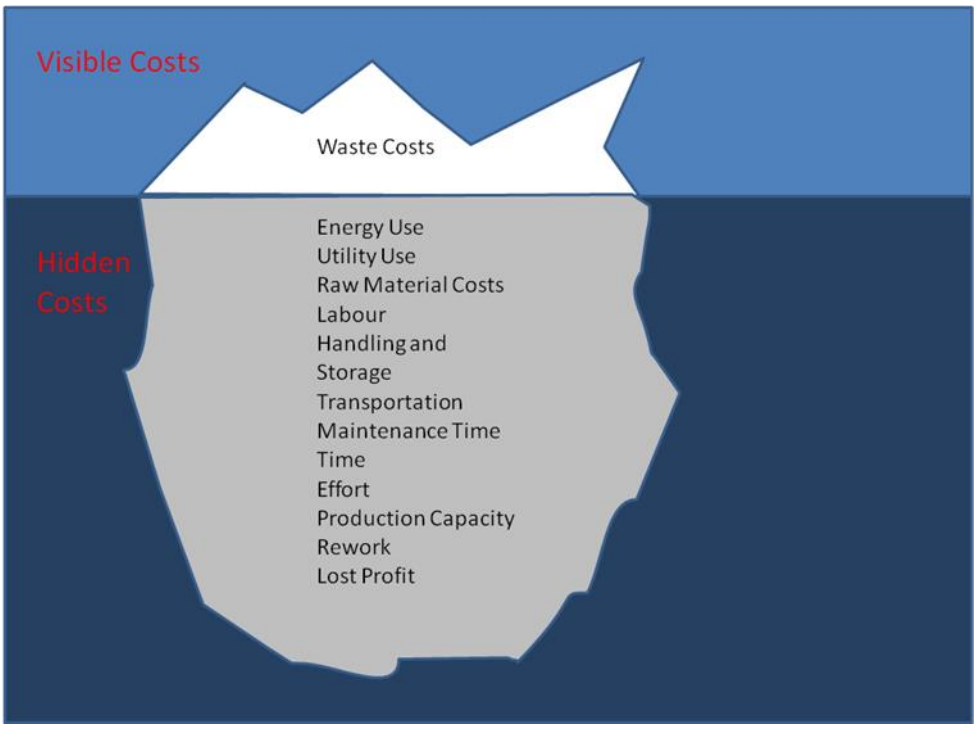
It has been estimated that the food and retail industries produce about 30% of all industrial and commercial waste in the UK and volume figures range between 18 – 22 million tonnes (mt) per annum. Waste is generated at various stages in the chain. UK homes alone are responsible for 6.7 mt of food waste and an additional 5.2 mt of food-related packaging (Hogg et al., 2007; WRAP, 2008). It is estimated that this would generate at least 15 mt of CO_2, mostly embedded energy and methane emissions from landfill (Hogg et al., 2007). For the retail sector there is a wide range of figures; the Cabinet Office recently reported 0.4 mt of waste per year, while WRAP reported 1.5 mt {{17 WRAP 2007}}and Envirowise (2002) 12 mt. Reported figures for food manufacturers also present a wide range going from 3.5 mt {{17 WRAP 2007}}to 6.6 mt (Cabinet Office, 2008). These ranges appear to indicate that waste data for food manufacturing and retail is based on rough estimates and are likely to have a high degree of error.

The waste problem is not exclusive to the UK; it has been acknowledged that the European food system produces an enormous amount of waste from both packaging and food (Ethical Corporation, 2006) and it has been estimated that approximately 25% of material that is introduced into the supply chain is wasted (C-Tech Innovation Ltd, 2004; Green and Johnston, 2004). Charities such as FareShare have estimated that up to 25% of the food sent to landfill by the food manufacturing and retail industries is either edible or could be turned into compost or energy (Green and Johnston, 2004). It is thought that this could feed more than 250,000 people which has provided a raison d'être and growth for charities such as FareShare.

Waste can be divided into avoidable and unavoidable streams when items of food cannot be processed further into by-products or co-products. Unavoidable waste mostly comprises inedible parts of raw food, for example, fruit and vegetable produce with inedible skin/peel will cause waste if it is to be prepared into a 'ready to eat product'. There is scope for further study into the causes, limitations and usage of the unavoidable waste created by production and manufacture of certain foodstuffs. For example, the UK poultry industry produces 150,000 tonnes of feathers every year, which costs the industry around £3 million in landfill charges per annum (C-Tech Innovation Ltd, 2004).

The overall cost of waste is often undervalued (Binyon, 2007) since many of the costs associated to dealing with waste are "hidden costs", as shown in Figure 1. It follows that an item wasted at a later stage in the supply chain has had more production, transportation, energy use and additional costs attributed to it, therefore the higher the waste value of that item. Raising awareness of these hidden costs could be a catalyst for resolving the problem as business will start to realise the scale of the problem and its impact on the bottom line.

Figure 1: The true cost of waste from hidden costs (Binyon, 2007).



2.3. Structure of the document

Following this introduction, section 3 presents an overview of the available literature concerning waste in food supply chains and presents some of the main supply chain initiatives that are affecting waste, both positively and negatively. Section 4 discusses the methodology used for the project, outlining the research design and the methods for collecting and analysing data. The findings are discussed in section 5, which consists of a brief description of each of the cases, a cross-case analysis, an analysis of root causes and a discussion of good practices. Finally, Section 6 presents the conclusions and recommendations from the project.

3. Systematic Review

3.1. Food and Drink Industry Structure

The food and drink industry plays an essential economic and social role. It serves the 60.9 million inhabitants of the UK (Office for National Statistics, 2008) who spend on a yearly basis over £106 billion (incl. VAT) on food, drink and tobacco (ONS, 2008), which equates to around £1,750 per capita. In addition, over £81 billion is spent on catering services (ONS, 2008). The industry accounts for 7% of the Gross Value Added (GVA) and provides employment to 3.7 million people, representing around 14% of total employment. However, the industry also has negative impacts in the form of waste, pollution, CO_2 emissions and exploitation of natural resources.

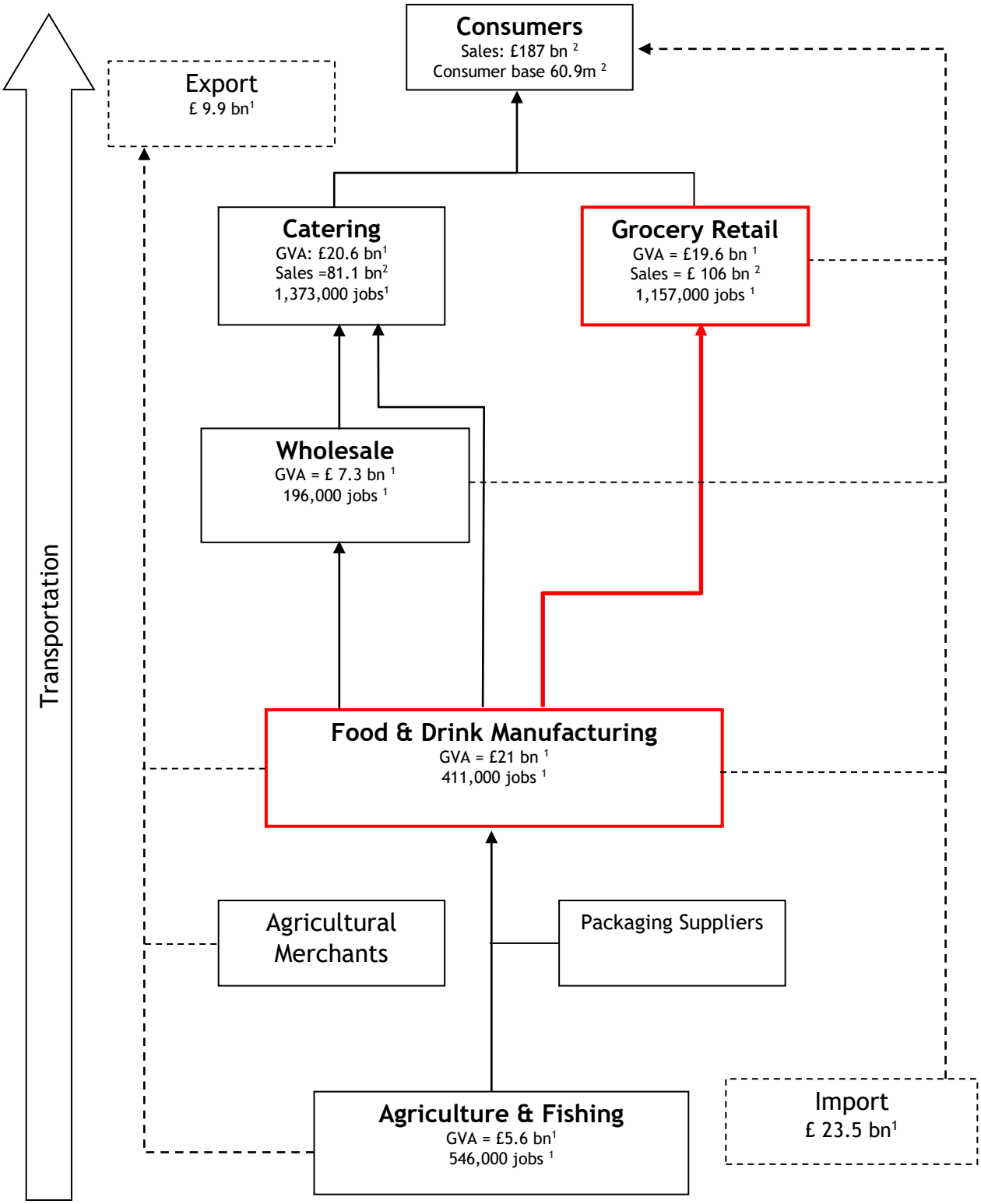
The food and drinks supply chain has six main participants: consumers, retailers, caterers, wholesalers, manufacturers and primary producers (including farming and fishing). Other participants in the industry include packaging suppliers, agricultural merchants, logistics service providers and waste managers. Figure 2 depicts this structure including some headline figures such as GVA, total sales and number of jobs, at each stage in the chain. This study focuses on two of the largest sectors in terms of employment and GVA: retail and manufacturing.

3.1.1. Consumers

The UK food and drink supply chain is a complex network of organisations that is continuously adapting to satisfy changing customer demands. This involves identifying new trends in customer demands such as increasing emphasis on healthy eating or concern for ethical issues and then introducing new products or adapting existing products to satisfy customers. In this way consumers play a key role in shaping the structure of the food supply chain.

Figure 3 presents a profile of consumer expenditure for food, beverages and tobacco. It shows that the largest categories in terms of expenditure are meat, bread and cereals and vegetables. Table I presents consumption data between 2004 and 2008, showing that the fastest growing categories are oils and fats (62%), fish (52%) and fruits (40%), while the two largest categories, meat (21%) and cereals (27%), are actually growing at below average (31%) rates. This has implications for the supply chain since two of the fastest growing categories tend to have short shelf lives and require temperature-controlled supply chains; factors which could be affecting overall levels of waste, both at the household and across the supply chain.

Figure 2: The UK Food and Drinks Supply Chain



Sources: 1. Defra (2007b) Food Statistics Pocketbook
2. ONS (2008)

Note: GVA = Gross Value Added

Note: Some values differ between sources

Figure 3: Household final consumption expenditure - Food and non-alcoholic beverages (£m)

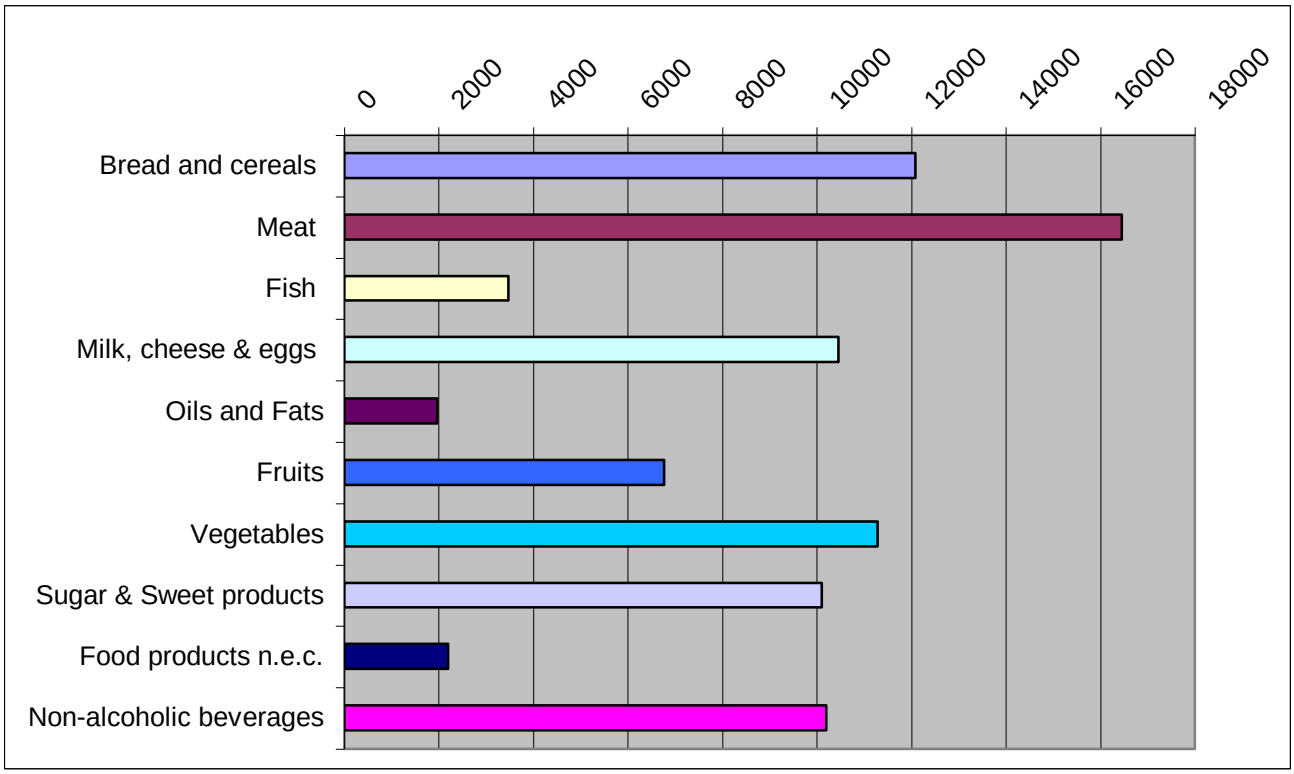


Table I: UK Consumer Expenditure on Food by Sector at Current Prices (£m at rsp) 2004-2008

	2004	2005	2006	2007	2008	Change 2004-2008
Bread and cereals	9480	9815	10124	10571	12081	27%
Meat	13597	13622	13867	14859	16459	21%
Fish	2290	2488	2726	3260	3471	52%
Milk, cheese & eggs	8006	8415	8675	9280	10455	31%
Oils and Fats	1216	1256	1333	1563	1969	62%
Fruits	4824	5311	5703	6416	6769	40%
Vegetables	8413	8824	9143	10344	11280	34%
Sugar & Sweet products	7245	7349	7434	8945	10104	39%
Food products n.e.c.	1596	1610	1622	1887	2202	38%
Non-alcoholic beverages	8163	8497	8783	10019	10203	25%
Total food and non-alcoholic beverages	**64830**	**67187**	**69410**	**77144**	**84993**	**31%**

rsp – retail selling prices
Source: Consumer Trends Q4 2008, National Statistics website
NB. tobacco and alcoholic beverages are excluded from the study

There are a number of economic, demographic and social trends that affect the consumer and as a result, the industry as a whole. Some of these trends are briefly described below:

- **Economic trends:** After a decade of favourable economic climate the situation started to deteriorate in 2006. On the supply side, prices for many agricultural commodities have increased substantially since 2006 as a result of increasing demand from Asian countries, higher energy costs, poor harvests and certain policies such as support for the use of bio-fuels (Cabinet Office, 2008). This has led to an increase of 6.9% in the basket of food in the Retail Price Index (RPI) between April 2007 and April 2008 (Defra, 2008). On the demand side other economic factors are being experienced such as the credit crisis, a reduction in consumer confidence and a general economic slowdown which could lead to a recession.

  The food industry is comparatively less sensitive to variations in income, and the share of food in total spending tends to increase during times of economic slowdown. However, it is possible that consumers will trade-down to cheaper alternatives. This has been popularised by the "Aldi effect", referring to the German discount retailer which has seen its sales increase by 21% in recent months, whilst other retailers have reacted by expanding their range of own brand products (Lyons 2008). Another possible consequence of the economic downturn could be that customers try to throw less food away and shop smarter by avoiding unnecessary purchases.

- **Population structure**: The UK population is growing slowly and it is expected that between 2007 and 2012 it will increase by about 1 million (Mintel, 2007). However, the structure of the population will continue to change. Some of the most significant changes are the decrease in the number of children, the increase in the group between 15-24 and rapid increases for the groups of over-45 and over-65 (Mintel, 2007). Associated with these trends are the reduction in household size and the increasing number of people living alone (Mintel, 2007). These trends are likely to affect demand patterns for food products, such as an increase demand for fresh, local and premium products and a decrease in large packs sizes (Mintel, 2007).

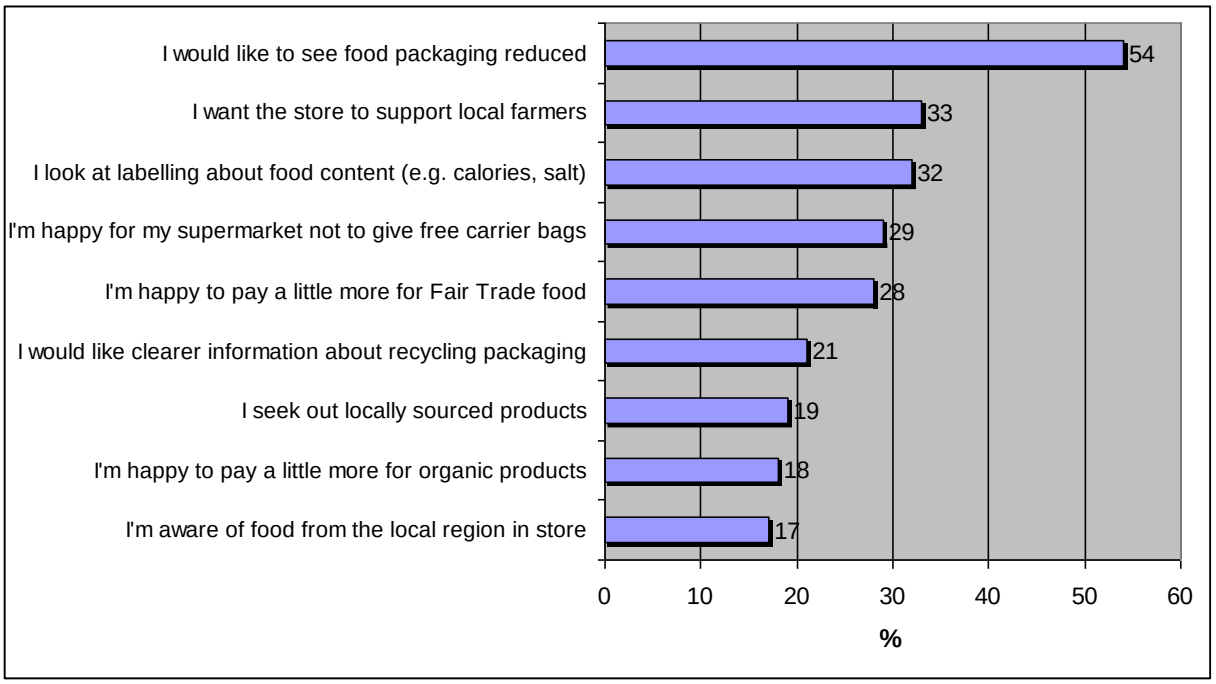
- **Changes in lifestyle**: Other social trends are affecting the demand for food and drink and we have identified two that are particularly relevant to this project.

  - Healthy eating: Consumers are becoming more health conscious increasing the demand for products with lower fat, calories or salt, as well organic produce. This has been reflected in the increasing demand for fruit and vegetables (Cabinet Office, 2008). This trend affects the entire supply chain and companies have to address these issues in order to remain competitive. Similarly it could have an impact on waste, as fruit and vegetables tend to have a shorter shelf life.

  - The ethical consumer: consumers are increasingly concerned about ethical issues such as fair trade, animal welfare, support for local farmers and impact on the environment which encompasses a number of issues such as climate change, waste, pollution, pesticides and food miles (Cabinet Office, 2008;

Mintel, 2007). Figure 4 presents the results of a survey on attitudes towards grocery shopping and indicates that waste related issues, such as packaging waste, carrier bags, recycling are considered important by consumers. However, there appears to be a gap between what people do and what they say (Cabinet Office, 2008).

Figure 4: Attitudes towards grocery shopping



Source: {{99 Mintel 2006}}

3.1.2. Retailing

Total household expenditure on food, beverages and tobacco through UK retailers for 2007 was estimated at around £106 billion (ONS, 2008) representing around 46% of total retail sales (Mintel, 2007). This figure has been increasing steadily since the 1970s and in the last ten years has grown by 37% (ONS, 2008). However, if only food and non-alcoholic beverages are considered the figure goes down to £76 billion.

The retail sector is represented by over 55,000 enterprises, with over 100,000 outlets employing over 1.157 million people (Defra, 2008; Defra, 2007a). Major multiples (with turnover greater than £1 billion), dominate the market, particularly the 'Big Four' supermarket groups, Tesco, Sainsbury's, Asda and Morrisons, which account for 75% of grocery sales (Cabinet Office, 2008).

Figure 5 and Table II present till roll data for the leading retailers comparing the 12 weeks to June 2009 with the same period for 2008 and 2007. These figures show that Tesco continues to have a commanding lead with close to 31% of the market. However, growth for Tesco has been slower than for some of its competitors, particularly when compared to some of the discounters such as Aldi and Lidl, which have experienced much faster growth rates.

Figure 5: UK Supermarket Sales 2007-2009 (12 weeks till roll)

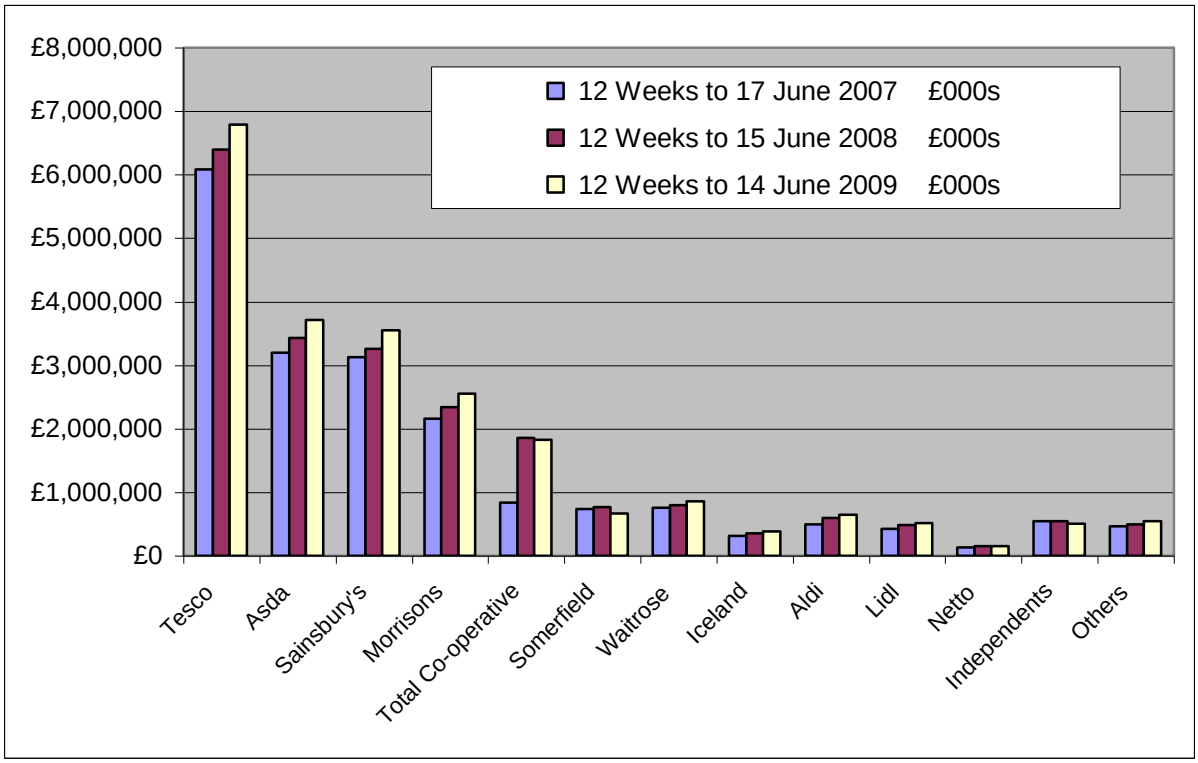


Table II: UK Supermarket Sales 2007-2009 (12 weeks till roll)

	12 Weeks to 17 June 2007		12 Weeks to 15 June 2008		Change
	£000s	%	£000s	%	%
Total Till Roll	**27,453,255**		**28,256,150**		**2.9**
Total Grocers	**19,272,003**	**100.0%**	**20,460,948**	**100.0%**	**6.2**
Total Multiples	**17,887,744**	**92.8%**	**19,050,222**	**93.1%**	**6.5**
Tesco	6,080,382	31.6%	6,392,222	31.2%	5.1
Asda	3,198,374	16.6%	3,438,175	16.8%	7.5
Sainsbury's	3,126,682	16.2%	3,262,042	15.9%	4.3
Morrisons	2,162,141	11.2%	2,337,697	11.4%	8.1
Somerfield	736,923	3.8%	767,119	3.7%	4.1
Kwik Save	27,608	0.1%	-	0.0%	-100
Waitrose	754,776	3.9%	794,343	3.9%	5.2
Iceland	315,059	1.6%	354,107	1.7%	12.4
Netto	128,041	0.7%	130,242	0.6%	1.7
Lidl	425,370	2.2%	479,644	2.3%	12.8
Aldi	494,563	2.6%	597,011	2.9%	20.7
Farm Foods	91,106	0.5%	103,332	0.5%	13.4
Other Freezer Centres	44,150	0.2%	48,236	0.2%	9.3
Other Multiples	302,569	1.6%	346,051	1.7%	14.4
Total Coops	**840,713**	**4.4%**	**863,994**	**4.2%**	**2.8**
Total Independents	**543,547**	**2.8%**	**546,732**	**2.7%**	**0.6**
Total Symbols	190,939	1.0%	195,337	1.0%	2.3
Other Independents	352,608	1.8%	351,396	1.7%	-0.3

Source: TNS Global 2008
http://www.tnsglobal.com/_assets/files/TNS_Market_Research_grocey_market_share_June08.html (last visited 19-08-08)

A spectrum of retail formats, ranging from convenience stores through to hypermarkets, is available in the UK. These diverse formats are intended to serve different customer segments and tend to stock different product ranges. It is likely that the different formats will lead to different levels of waste. Table III summarises the characteristics of the main retail formats and comments on the implications that each store format can have on waste.

Table III: Retail Formats

Convenience	• Small stores with sales area up to 3,000 sq. ft. • Usually located in busy city centres, residential areas, small towns, petrol station forecourts. • Stocking mainly food (higher margin products such as ready meals), everyday essentials, newspapers, magazines, tobacco products and a limited range of alcoholic beverages. • Product selection is limited when compared to other formats. • Waste as a percentage of sales is likely to be higher than in other formats due to the higher proportion of short shelf life products such as sandwiches and chilled foods.
Supermarket	• Sales area between 20,000 and 50,000 sq. ft. • Larger than convenience stores and offers a wider selection of products. • Usually located close to residential areas to be convenient for consumers. • Offers a wide variety of food and household merchandise and some offer a limited range of non-food products. • Convenient shopping hours (some are open 24 hours). • Wider product range and ample shopping hours could result in lower volumes of food waste compared to convenience stores.
Hypermarket	• Sales area range above 60,000 sq. ft. • Usually located in suburban or out-of-town locations that are accessible by car. • Large retail facility which carries an enormous range of products. Full lines of groceries and general merchandise including electronics, clothing, furniture, etc. • Provides additional services such as photo processing, opticians, café, restaurant, cash machines, etc. • Convenient shopping hours (some 24 hours). • Wider product range and ample shopping hours could result in lower levels of food waste as a proportion of sales. However, waste non-food products due to damage could be substantial in terms of value.

3.1.3. Manufacturing

The food manufacturing industry comprises a variety of sectors and processes such as: meat and poultry processing, brewing, dairy, confectionery and frozen ready meals, to name but a few. In the UK, the majority of food manufacture is performed by very large organisations, which operate across a range of food markets (Fenn, 2007), with the largest 3.8% of firms generating over 75% of all food manufactured in the UK (Cabinet Office, 2008).

The UK food and drink manufacturing sector, had estimated sales of £114 bn for 2006 (Fenn, 2007) and a GVA of £21 bn (Defra, 2007a). This makes food and drink the largest manufacturing sector in the UK with around 17% of all manufacturing (Cabinet Office, 2008). Reports on the number of companies in the industry range between 6,657 and 6,270 (Fenn, 2007) and the total number of employees has been estimated at around 411,000 (Defra, 2007a).

It is estimated that about 75% of food manufacturers' sales go to retailers, compared with 10% to caterers and 15% in exports (Cabinet Office, 2008). It has been argued that this puts the large retailers in a strong bargaining position creating pressure to reduce costs and is probably one of the causes of increasing consolidation in the industry (Cabinet Office, 2008; Fenn, 2007).

The industry is highly concentrated and it has been estimated that the largest 3.8% of food manufacturers produced 76.5% of all the output in 2004 (Defra, 2007a). These larger firms, which have a stronger bargaining position compared with retailers, tend to have larger margins than smaller firms. Table IV presents a list of the UK's leading food producers including a brief description of their activities and data concerning turnover, profits and employment. Beverage manufacturers such as Diageo, Allied Domecq and Scottish & Newcastle have been excluded from the list.

Waste has been a long-standing concern of the food manufacturing industry and many companies have addressed this issue through quality systems and continuous improvement processes. However, food manufacturing processes also cause some waste which is inevitable such as skins, carcasses and other trimmings. Specific issues related to food manufacturing waste will be addressed in the following section.

Table IV: UK's largest food manufacturers

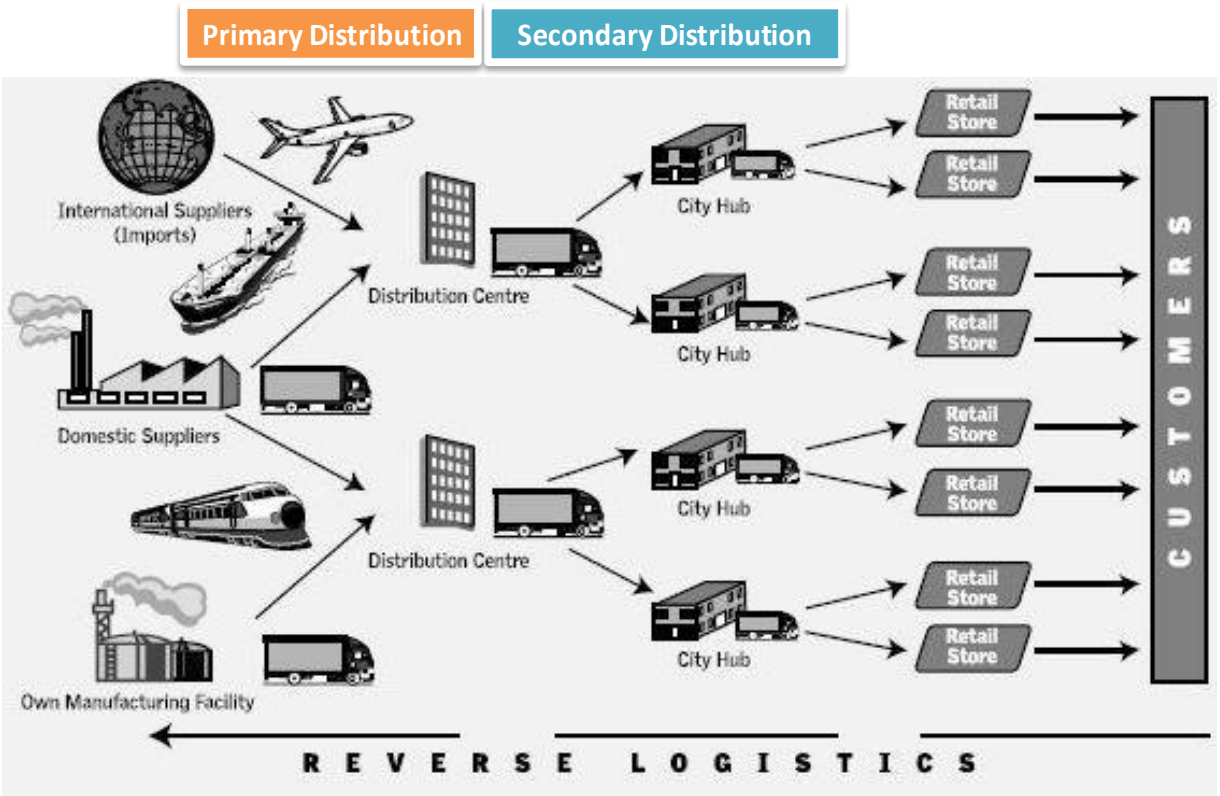
Company	Brief Description	Turnover / Profit 2008	Employees 2008
Associated British Foods PLC	Diversified multinational. Main sectors include sugar, bread, tea and oil.	£8.2bn / 664m	96,000
Vion (formerly Grampian Country Food Group)	Fresh, frozen and added-value chicken, pork, beef, lamb and turkey products	£1.81bn / £40.5m §	17,000
Dairy Crest Group PLC	Chilled dairy foods (milk, cheese, yoghurt, desserts and ice cream)	£1.65bn / 103.2m	8,342
Nestlé UK Ltd.	Part of Nestlé, the world's largest food company. Provides a wide range of products including cereals, chilled dairy products, chilled meats, milk and cream, confectionery, and coffee, among others.	£1.27bn / £62.4	5,179
Premier Foods Group Ltd	Wide range of products including bread, cakes, preserves, beans, soup, noodles, vinegar, sauces, salt, chilled ready meals and desserts.	£2.60bn / -£404m	15,913
Unilever UK (Unilever PLC)	Unilever, the Anglo-Dutch giant, is one of the leading producers of FMCG, including food. Some of their leading food brands include PG Tips, Pot Noodle, Flora, Bertolli, Knorr, Ragu, Marmite, Hellman's, Coleman's and Slim Fast	UK: £1.59 bn / 82 m World: £38.93 bn / £6.85 bn	UK 3,834 World 174,000
United Biscuits	Leading European manufacturer of biscuits and snacks. Main brands include Hula Hoops, McCoys, KP Nuts, Jaffa Cakes, and McVitie's.	£999m / £61m	6,665
Northern Foods PLC	Produces a wide range of products in added-value convenience foods. Main markets include pizza, biscuits, ready meals, sandwiches, salads and puddings.	£931 / £45.4m	10,767
HJ Heinz Company Ltd	Subsidiary of HJ Heinz Company (USA). Main products include canned food (e.g. beans, pasta, fish), baby foods, biscuits, cakes, cereals and snacks, chilled desserts, dairy products, frozen desserts, ready meals, salads, salad dressing, sandwiches, sauces, soups and soya.	£675m / £153m	2,025
Uniq PLC	Supplies sandwiches, salads, desserts, salmon and seafood products, cheese, dips, party foods and ready meals to major supermarkets.	£797m / -£54.8m	6,350
Bernard Matthews Ltd	Frozen poultry products, cooked sliced meats, fresh poultry	£348m/ -£18m	5,144
Sources: Fenn, D. [Education.] (2007) Market Review 2007 – Food Industry, Keynote, ISBN 978-1-84729-228-5; Company websites; FAME Database (Bureau Van Dijk) § Results for 2006/7			

3.1.4. Logistics

The competitiveness in the market, the diversity of products on offer and the complexity of retail operations in the UK, demands a logistics system that has to be both efficient and adaptable. This is arguably the reason why logistics has become an important differentiator in the marketplace and retailers have used it as the mechanism to control, organise and manage end-to-end supply chains (Bourlakis and Weightman, 2004).

Given the enormous number of products managed by the large retailers there is a latent necessity towards the use of distribution centres. Retailers channel the majority of their products through distribution centres before reaching stores; some tend to use their own transportation fleets to replenish the stores, while others rely on third party logistics providers (3PLs) such as Eddie Stobart and Wincanton. Having greater control over secondary distribution (see Figure 6) means retailers might be able to manage their transportation and replenishment systems with greater efficiency. In this sense, they are heavily dependent on IT systems and, very often, logistics providers.

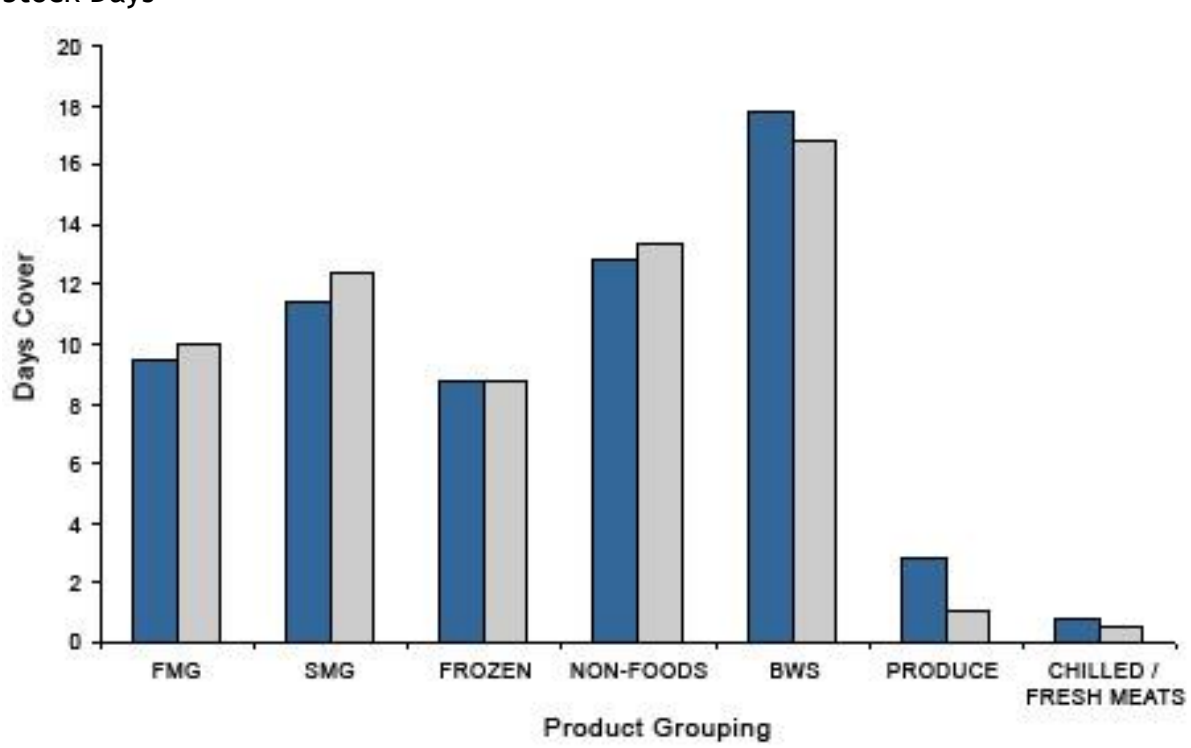
Figure 6: Retail Logistics (Source: adapted from {{47 Agarwal, V. 2007}})



Waste is influenced by a variety of factors and management practices. One of these relates to the way inventories are managed, as the higher the inventory level, the greater the likelihood that the product will be damaged or exceed its best-before date. Hence by improving inventory management, waste levels could be reduced. According to a report by IGD (IGD, 2007), the average warehouse inventory levels

increased to 11.6 days' cover in 2006 (excluding non-food, produce and chilled lines). However, the categories with the longer shelf lives such as beers, wines and spirits (BWS) and Non-Foods tend to have high stock levels while categories with short shelf lives, i.e. produce and chilled/fresh meats, tend to have the lowest stock levels, usually below 2 days' cover, as can be seen in Figure 7.

Figure 7: Inventory levels by product category



Source: IGD Retail Logistics 2007 report
Key: FMG = Fast Moving Goods
SMG = Slow Moving Goods
BWS = Beers, Wines and Spirits

Retailers manage products with different characteristics and logistics requirements. Therefore, the implementation of initiatives such as "composite distribution", stores' "common stock rooms" and the centralisation of SMG in dedicated warehouses, have brought substantial gains in terms of reduction of inventory and overall efficiency of the whole logistical system. Composite distribution refers to the "distribution of mixed temperature items through the same distribution centre and on the same vehicle" (Smith and Sparks, 2004). Common stock rooms are widely used in mixed retail businesses; the basic idea is that a group of stores share the stock from a common room strategically located in one of them according to demand requirements (Fernie and Sparks, 2004).

3.1.5. Wholesalers

Wholesalers connect the supply activities (agriculture and manufacturing) with the market activities (retail and catering), forming an essential link in the supply chain. The main services provided at this stage are warehousing, transportation, product consolidation, inventory management and retail/catering advisory services.

In 2007 the total number of food wholesalers was estimated at 14,096 with sales of £17.8bn and a total GVA of around £7.3 billion (Defra, 2007a; IGD, 2007). However, this is heavily concentrated in the large wholesalers and the top 30% (with annual sales of over £1 million) capture 93.5% of the sales (Mintel, 1999).

There are two main types of food and grocery wholesaler:

Cash and carry: where the customer buys and collects the goods from the wholesaler who generally offers a limited number of products such as cigarettes, general groceries, confectionery and soft drinks. Cash and carry operators account for 53% of the wholesale market (IGD, 2007).

Delivery wholesalers: offer a delivery service to the customer's location for a fee. This type of wholesaler offers a broad range of products including frozen and chilled, household, health and beauty, snack meals, fast food and leisure products and accounts for 47% of the market (IGD, 2007).

3.1.6. Primary producers

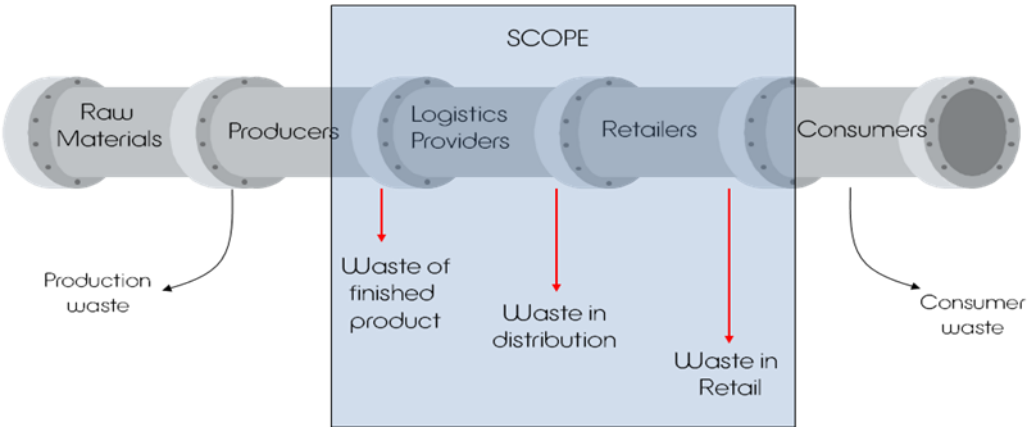
Primary production in the food and drinks industry comprises a wide variety of activities. The two main categories are farming and fishing. Farming contributes £6.6 billion a year to the UK economy, representing around 0.8% of the economy. It also provides employment to over half a million people and uses 18.6 million hectares of land [around three quarters of the UK's land area] (Defra, 2001). Fishing, the smaller of the two categories, contributes £660 million to the UK economy and provides 17,000 jobs (Defra, 2001). This latter category is beyond the scope of this project.

3.2. Waste in UK Food Supply Chains

3.2.1. Areas of waste

The area of focus for this project is the post-production/pre-consumer phase of the food supply chain as shown in Figure 8 (Mena, 2008). As mentioned previously, reports from WRAP have shown the volumes and values of waste produced at the consumer end of the supply chain (WRAP, 2007) to be one third of all food bought by consumers. Data gathered by C-Tech Innovation Ltd (2004) showed that the food sector accounted for over a third of all the waste products in the UK in 2004 which equated to a total of 17 mt.

Figure 8: Focus of this research



The research also showed that approximately 15% of this 17 mt arose from food manufacture and a further 21% from distribution, retail and consumption (C-Tech Innovation Ltd, 2004). Separate Government figures suggest that roughly 17 mt of food are being put into landfill at a cost of over £175 million a year (Defra, 2007b).

For this project, the three key areas of study include:

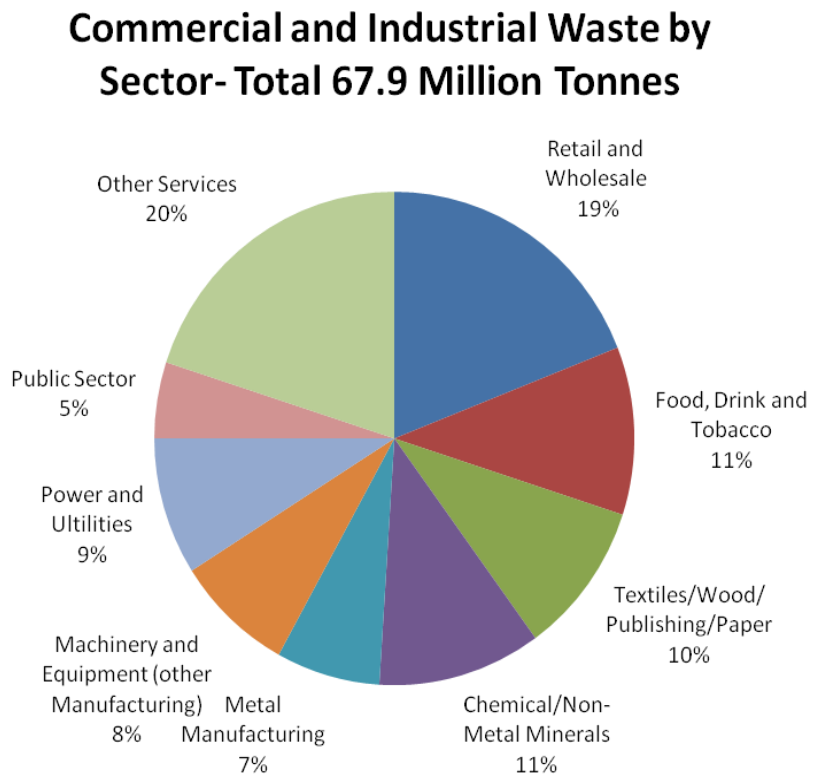
- Retail
- Distribution
- Production

It is anticipated that there will be significant findings of waste of materials in these areas as current statistics show this trend. From Figure 9, it can be seen that the main contributors to waste in the commercial and industrial sectors are the retail and wholesale, and food, drink and tobacco industries (Defra, 2007b). The majority of waste in the years of this study (2002/03) came from retail and wholesale (19%) and the food, drink and tobacco sector (11%). This equates to over 20 mt of waste from these combined sectors.

The food industry has worked together with government agencies and other organisations such as WRAP to deliver actions on this amount of waste which has led to agreements, such as the Courtauld Commitment, for the reduction of packaging waste and identifying areas of food waste. Of the 7 mt of waste produced each year by the food, drink and tobacco industry it is estimated that 4.1 mt are food or food

processing by-products, which constitutes nearly two thirds of the total commercial and industrial food waste. The majority of this food waste often returns to the supply chain for use in food production or food processing but about 1.9 mt (≈ 46%) of this is land-filled directly (Defra, 2007b). The Food Industry Sustainability Strategy has given a target of a 15-20% reduction in the food manufacturing industry's own waste by 2010. The implementation of this target is now being discussed (Defra, 2006).

Figure 9: Wastage figures from industry and commerce by sector (Defra, 2007b).



Source: Environment Agency Commercial and Industrial Waste Survey 2002/03

The supply chain layout for the UK is shown in Figure 10. This diagram shows the flow of materials through the industry from raw materials to end consumers. It also identifies income from sales as well as the value adding to the food from these sales. This highlights another problem in the cost of waste, in that a food item could have several different prices or values attributed to it throughout the supply chain. This draws attention to a need for a standard of measuring for waste, including packaging and material waste, to be used in this project. It is expected that throughout the course of this investigation, a best practice of estimating values of waste will arise from communications with several of the project partners.

The waste that has been described in Figure 10 shows only the gross value at that stage of the supply chain. This project will look to identify the root causes of these wastes help identify wasteful processes and inefficient operational techniques as

well as possible solutions to waste reduction. This will correlate to round table discussions already occurring as a result of the Courtauld agreement (Defra, 2007b).

Although out of the scope of this project, it is worth noting the waste recorded from agriculture and raw food manufacture. The amounts of waste in this diverse industry run at about 30-40% of production (C-Tech Innovation Ltd, 2004) which is extremely high.

The shrinking size of the food wholesale market means that any surplus or "rejected" food items have nowhere to move up the supply chain. The management of this waste is well practised and often involves re-ploughing or composting for crops and specialist retail streams for livestock waste. An example of waste becoming a resource can be found in the meat and livestock sector. The hides and skins from the animals can be used as valuable resources for the leather industry which prevents increases in landfill volumes and therefore costs.

3.2.2. Waste in Retail operations

From Figure 9 it can been seen that there will be large volumes of waste found in Retail, although this sector also covers many non-food products. However, food retail is likely to be an important contributor due to the prevalence of short shelf life products, many of which require temperature control and in many cases are sold in a compound form (an example being sandwiches, which contain varied, processed ingredients that are not able to be reversed into raw ingredients).

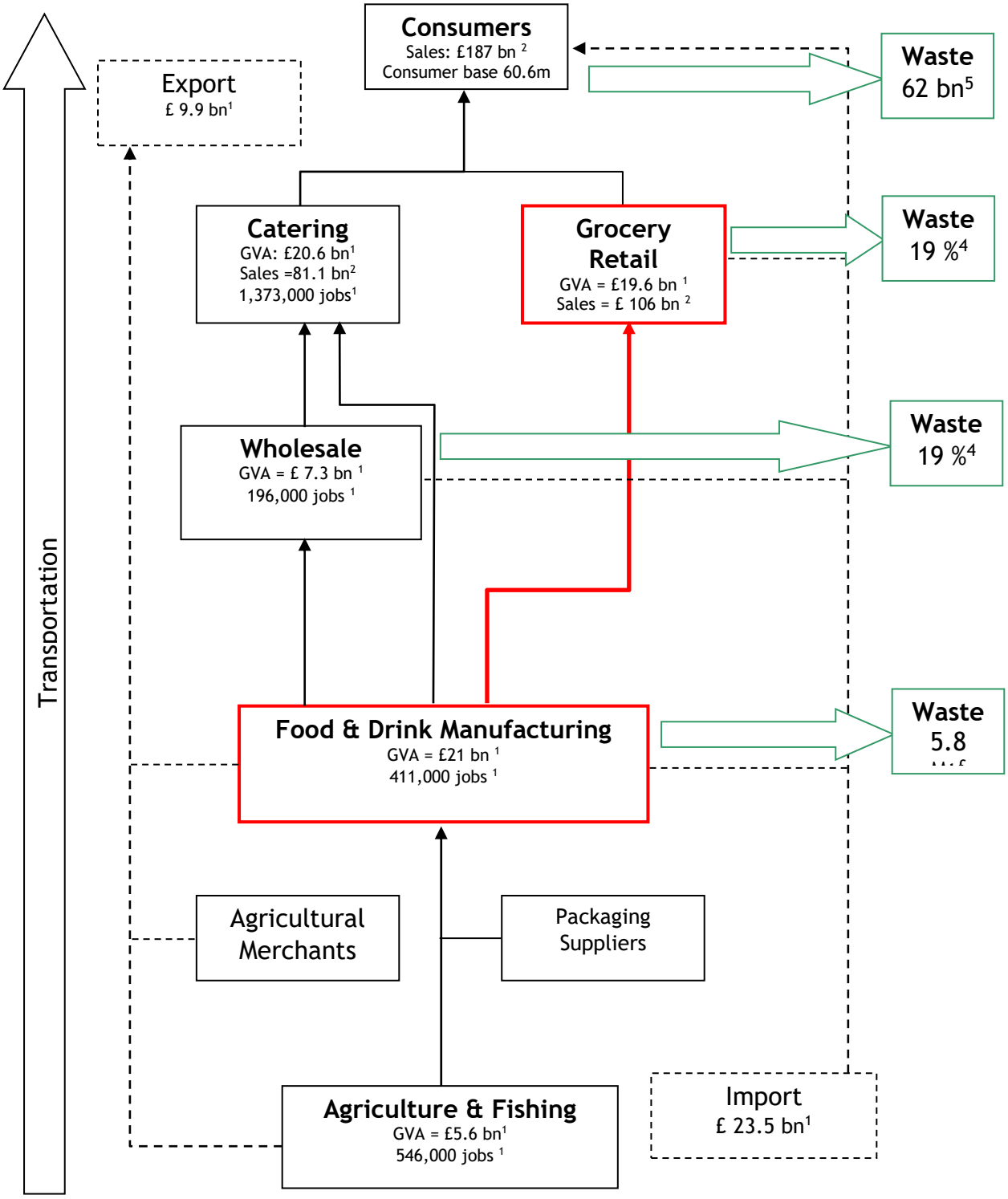
In terms of the value-add, the most valuable items can be found at the highest point of Figure 10. It would seem that the highest 'costs' of waste are arising from this retail stage. As expected, the larger supermarkets are responding to these costs and the Courtauld Commitment to fall in line with legislation and the Food Industry Sustainability Strategy (FISS) as well as to recoup any financial reward from minimising potential waste. This agreement aims to:

- Design out packaging waste growth by 2008
- Deliver absolute reductions in packaging waste by 2010
- Identify ways to reduce food waste

The agreement represents 92% of UK grocery supermarkets and over 30 major retailers, brands and suppliers which include names like Heinz, Sainsbury's and Procter and Gamble. The agreement has delivered on its first target by zeroing growth in packaging waste, despite increases in sales and population (WRAP, 2008). This was accomplished using innovative packaging formats, reducing the weight of packaging and increasing the use of refill/self-dispensing systems with collaboration on packaging design guidance.

There is also evidence of managing waste by using reusable green packaging trays and cutting down on cardboard (estimated saving of 132,000 tonnes of cardboard saved so far since the introduction in 2006) as well as being involved with FareShare to distribute surplus food to avoid landfill (TESCO, 2007).

Figure 10: The economic summary of the UK food chain.



Sources:
1. Defra (2007c) Food Statistics Pocketbook
2. ONS (2008)
3. Biffaward (2006) The Mass Balance Movement
4. Defra (2007c) Waste Strategy for England 2007
5. WRAP (2007) Understanding Food Waste

Note: Some values differ between sources

3.2.3. Waste in Manufacturing and Distribution

This sector inevitably causes waste. As discussed previously, this waste might be from an unavoidable source, such as vegetable skins and animal carcasses, or from food trimmings and processing. Figure 11 presents the example of tea biscuits resulting from a mass balance analysis. This analysis shows that the process generates 3.5 tonnes of visible waste per 75 tonnes of production, this equates to 4.6% of output.

Some of this is lost as visible quantifiable waste; other losses of mass might be caused by water vapour escaping during the baking process. This method of mass balance is used in the industry to benchmark waste efficiencies of food production (C-Tech Innovation Ltd, 2004). In other convoluted food processes that require several ingredient streams and cooking steps, such as readymade meals, it can be much more difficult to estimate manufacture waste. Using the above method for each step simplifies the end calculation as long as mass measurements are reliable.

Distribution of food post-manufacture also poses a challenge to food waste. The segments at highest risk at this stage are the chilled and frozen food segments which depend on a constant temperature to avoid food spoilage. Other challenges include damage caused by transit and errors emerging from forecast discrepancies which are not passed on to retailers (Food and Drink Federation, 2007; Fellows, 2000).

Figure 11: The Mass Balance process for United Biscuits McVitie's Tea Biscuits production (C-Tech Innovation Ltd, 2004)

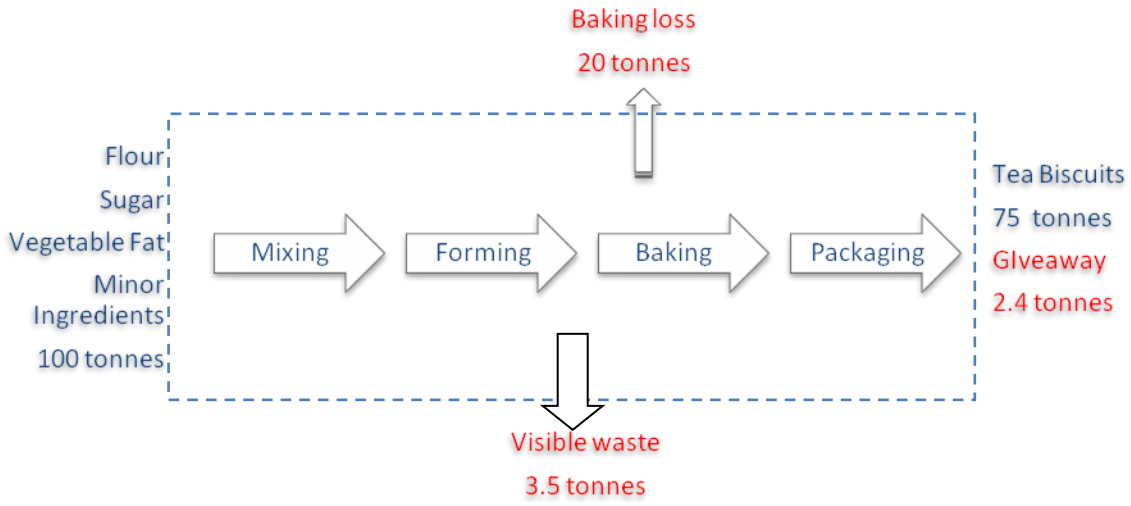


Table V shows some of the key points identified by research into the increase in waste in production and distribution (Fellows, 2000). This project will investigate reasons why such waste matter occurs, as well as relating best practices for avoiding and dealing with that waste.

Table V: Food processing unit operations and associated wastes (Fellows, 2000)

Category	Operations	Example Wastes produced
Ambient Temperature Processing		
Raw Materials Preparation	Cleaning, Sorting, Grading and Peeling.	Cleaning water effluent (BOD or COD), peelings, hair, feathers, grit, blood, contaminated foodstuffs.
Size Reduction	Chopping, Cutting, Slicing, Dicing, Milling of Solid Foods, Pulping, Emulsification and Homogenisation of Liquids.	Poor Quality (too course/fine) products with loss of nutritional/sensory characteristics. Dust agglomerates. Waste off-cuts. Fat bearing effluents from colloidal products (e.g. Dairy). Risk of pathogenic contamination in emulsification (e.g. Dairy)
Mixing and Forming	Mixing, Forming malformed pieces.	Wrongly proportioned batches, poorly mixed ingredients.
Separation and Concentration	Centrifugation, Filtration, Expression, Solvent Extraction, Membrane Concentration.	Separated solids (e.g. after clarification of liquids), press residues (e.g. fruit juice extraction).
Fermentation and use of Enzymes	Fermentation, Enzyme Technology.	Spent biomass.
Other	Irradiation Pulsed Electronic Field, High Pressure, Pulsed Light and Ultrasound.	
Processing with Heat Application		
Preservation/stabilisation	Blanching, Pasteurisation and Sterilisation.	Under blanched food wastage, effluent, thermophillic bacterial contamination, heat spoilage, heat transfer surface film build-up and product loss due to unsuccessful treatment.
Evaporation and Distillation Extrusion	Evaporation and Distillation Extrusion.	Heat transfer surface film build-up, distillation residues, strip down residues.
Dehydration	Hot air driers, Heated surface driers, Rehydration.	Heat transfer surface film build-up.
Baking and Roasting	Direct and indirect heating ovens, Batch and Continuous ovens.	Write off of oven contents if process interruption exceeds products' buffering capacity.
Frying	Shallow Frying, Deep-fat frying.	Contaminated fats and particulates
Direct and Radiant Heating	Dielectric Heating, Ohmic Heating Infrared heating.	
Processing with Heat Removal		
Chilling	Fresh foods, processed foods, Mechanical refrigerators, Cryogenic chilling, Chill Storage, Modified and controlled atmosphere storage and packaging.	Spoiled food in equipment failure
Freezing	Freezing.	Spoiled food in equipment failure and thawed water.
Freeze Drying and Concentration	Freeze drying and Freeze Concentration.	
Pre & Post-Processing Operations		
Coating and Enrobing	Battering, Coating and Dusting.	Over/under coated product and appearance failures.
Packaging Filling and Sealing	Packaging, Filling and Sealing.	Packaging waste, product give away and spoiled goods if seal fails.
Handling, Storage and Distribution	Raw Materials and ingredients, Waste management and disposal, Storage and Distribution.	Losses due to transit damages and mismatch of forecast to actual demand.

3.2.4. Packaging

It has been estimated that 10.5 mt of packaging entered the UK waste stream in 2006 (Defra, 2007b) and according to Environwise, the food and drink industry is responsible for over 50% of this (Binyon, 2007). Over 5 mt of food industry packaging enters the waste stream every year and in terms of raw materials alone costs £4 billion. Adding on other expenses such as disposal and recovery payments would give a more accurate, and larger, figure of the cost. There are also environmental costs involved in land filling packaging, such as greenhouse gas emissions as well as low bio-degradation rates.

Packaging serves multiple purposes; on the one hand it protects the product and can extend its shelf life; on the other it inevitably generates waste. Packaging has proved itself necessary for the modern production of food and the majority of waste created from packaging materials comprises glass, cardboard and plastics which can be reused and recycled so disposal to landfill is not an effective use of these resources. The decisions about how much packaging and what kind of packaging to use are critical; however, they are not simple decisions and trade-offs have to be considered.

3.2.5. Policies and Practices (UK and EU)

This section provides an overview of the current policies and legislation relating to waste and the food and drink industry. The majority of the information has been collated from two sources (C-Tech Innovation Ltd, 2004; NetRegs, 2008). The right legislation aims to prevent waste from occurring as well as increasing recycling, energy recovery and other waste minimisation methods by making them more attractive and necessary as waste management approaches (Food and Drink Federation, 2007).

Table VI shows a summary of the main EU and UK legislation relevant to the food and drink industry. In terms of the EU directives, they were all introduced to set up adequate waste control and waste management. The Waste Framework Directive, introduced in 1975 and revised in 1991, deals with the regulatory framework for the implementation of the European Commission's Waste Management Strategy of 1989, covering waste avoidance, disposal and management. The hazardous waste directive was introduced in 1991 to align management of these materials across Member States. The UK uses special waste regulations to conform to this directive and includes lists and definitions of special wastes as well as provisions for their treatment, storage and disposal. The food industry treats items unfit for human consumption, such as preservatives or peeling sludge as special waste.

The Integrated Pollution Prevention and Control (IPPC) directive introduced methods such as the "polluter pays" to attempt to reduce pollution at source by using BAT (best available techniques). The polluter pays for the environmental damage they are deemed to have caused to air, soil or water. In the UK, the Pollution Prevention and Control Act, 1999, is used for this purpose against large food and milk processing operations including intensive poultry and pig farming.

Table VI: Selected European and UK waste related legislation {{36 C-Tech Innovation Ltd 2004}}.

European	Main Features	UK	Main Features
Framework Directive on Waste 75/442/EEC (91/156/EEC)	Waste control regimes and waste management plans. Regulatory framework for 1989 waste management strategy.		
		Environmental Protection Act 1990	Waste management licensing. Integrated Pollution Control (IPC). Waste producers duty of care. BATNEEC
Hazardous Waste Directive 91/689/EEC	Definitions of hazardous wastes. Wastes requiring special disposal.	Special Waste Regulations 1996	Implementation of Hazardous Waste Directive. Storage, treatment and disposal of hazardous controlled wastes. Definitions and lists of special wastes, including several food related categories.
		Environmental Act 1995	Environment Agency (SEPA in Scotland) as a primary enforcement body. Producer responsibility for waste.
Integrated Pollution Prevention and Control 96/61/EC	Prevention of waste at source, "polluter pays" principle, Best Available Techniques (BAT).	Pollution Prevention and Control Act 1999	Phased in enactment of IPPC Directive including major food processing and agri-operations
		The Pollution Prevention and Control (England and Wales) Regulation 2000	
		Pollution Prevention and Control (Scotland) Regulations 2000	
Landfill Directive 1999/31/EC	Proscription of landfilling certain hazardous wastes. Reduction targets for biodegradable municipal waste.	Landfill (England and Wales) Regulation 2002	Designation of Landfill Directive in England and Wales
		Pollution Prevention and Control (designation of Landfill Directive) (Scotland) Order 2003	Designation of Landfill Directive in Scotland
Packaging and Packaging Waste Directive 94/62/EC	Reuse, Recycling and Recovery targets for packaging and packaging waste.	The Producers Responsibility Obligations (Packaging Waste) Regulations 1997 and subsequent amendments.	Implementation of Packaging Directives and amended (increased) targets for recovery and recycle levels.
Animal By-Products Regulation	Categorises animal by-products in three categories with stringent disposal requirements.	Animal By-Products Order 1999 (Amended 2001)	Limitation on use of material of animal origin to prevent disease entering the food chain.
		Water Resources Act 1991 Water Industry Act 1991	Water and effluent management, consents and charges.

The landfill directive's aim is to reduce landfill as a disposal route by prohibiting some hazardous and liquid wastes and by setting ambitious reduction targets for others such as biodegradable municipal waste (35% of 1995 figures by 2018 for the UK, with the 2004 figure at over 80% of biodegradable waste going to landfill). The directive was established to be used as a lever to force major change in the handling of some wastes and to promote more sustainable treatment and applications of new technologies. The UK has landfill regulations which are subject to ongoing amendments but with the targets of the EU directives in mind.

The directive on packaging was introduced with the intention of minimising the environmental impact of packaging and packaging waste. Other aims were to promote reuse, recycling and recovery of different articles of waste. Five-year targets were set including a 50-60% recovery of packaging waste and a 25-45% target of packaging to be recycled. The UK enforces this with it own regulations and further amendments. The regulations cover manufacturers, packers and fillers, importers and retailers of food products.

The EU regulation of animal by-products introduced in 2003 categorises waste into three sections:

Category 1: High risk to be incinerated.

Category 2: Materials unfit for human consumption. Most types of this material must be incinerated or rendered.

Category 3: Material which is fit for but not destined for human consumption.

The UK has its own order introduced in 1999 amended in 2001 and again in 2003 {{91 UK Government 1999;92 UK Government 2001;}}. This aims to minimise disease transmission such as BSE. The current legislation requires the prevention of feeding livestock catering waste which has come into contact with animal carcasses or material presenting similar hazards.

Further relevant UK legislation includes the Environmental Protection Act, 1990, {{93 UK Government 1990;}} which licenses companies handling controlled wastes and allocates the monitoring and enforcement of pollution control, usually by local authorities. The waste producer is expected to deal with their wastage by BATNEEC (Best Available Technique Not Entailing Excessive Cost.). The Environment Act, 1995 is used to promote producer responsibility for recycling, recovery and re-usage of resources. Wastewater legislation is complex and is an amalgamation of the Water Resources Act, 1991 and the Water Industries Act, 1991. The two primary concerns of these legislations are the release of water that is hazardous into the environment and responsible water resource management.

3.2.6. Good practices documented in the literature

Throughout the UK retail industry there are efforts to match the targets set by UK and EU directives mentioned previously. Many of these targets are focused on reducing the amount of waste that is sent to landfill. The range of these targets is

broad when considering the five largest food retailers (ASDA, Tesco, Sainsbury's, Morrison's and the Co-operative Group). These targets are available on the companies' own websites and also act as a marketing tool to show responsibility for the retailers' actions. Table VII shows an overview of the best practices from the top five retailers where the data has been sourced from their websites and published literature available online.

The future targets of these retailers range from total elimination of waste sent to landfill (ASDA and their food waste control) through to further commitments of waste used for energy production (Tesco and future targets for food waste controls). The table shows that there is serious commitment from the major players in the food retailing industry. All five major food retailers are committed to reducing the volume of waste being sent to landfill and to reducing packaging waste which is a direct effect of the Courtauld agreement.

Summarising the table, it is evident that ASDA has the most aggressive targets as they aim for total elimination of waste sent to landfill by 2010. This compares to the other retailers' targets of a 50% reduction by 2010 or even 2013 in the case of the Co-operative Group. All of the retailers have strict targets already that are set to tackle waste created within their operations and they are all aiming to reduce the amount of future waste from operations that is currently being sent to landfill.

Food waste control is also being dealt with by Tesco as they strive to deliver any surpluses of fresh food to homeless shelters etc. with their partnership with Fareshare. ASDA have focussed on reducing the dependence of its customers on plastic bags and is aiming to introduce more environmentally friendly bags made out of recycled materials. All of the retailers mentioned are planning to install more recycling facilities and reduce the amount of waste, mostly from packaging, which cannot currently be recycled.

In terms of packaging, current targets are aiming for a reduction of packaging (Asda 10% reduction on own brand food goods) and an increase in the use of recyclable materials (Sainsbury's organic range to increase to 90% recyclable packaging). General future targets from these five retailers all include a cut down of volumes of waste generated by packaging and an increase in the use of recyclable materials. There is also evidence of these retailers addressing their CO_2 emissions with pledges from three of them to reduce their carbon footprint and directly reduce their emissions of CO_2. The Co-operative Group has pledged to set up projects to investigate and reduce waste in their own brand products.

Table VII Good practices summary table of the main food retailers in the UK

Practices	Tesco		Asda		Sainsbury's[1]		Morrison's		Co-operative Group[2]	
	Targets achievements	Future Targets	Targets achievements	Future Targets	Targets achievements	Future Targets	Targets achievements	Future Targets	Targets achievements	Future Targets
Reduce waste created in the operations	Reduction of 9% of waste created by UK stores operations in 2007[3]. The amount of waste recycled has been 70%[4]. Currently projects to use one-way packaging with clearly readable labels by suppliers in the distribution operations. Reusable transit trays have saved over 130,000 tonnes of cardboard.	Recycle 80% of the waste by 2009. Reduction in packaging by 25% by 2010.	It launches initiatives to spread the utilisation of plastic bags made of recyclable materials.	Target zero waste to landfill by 2010.	A decrease of 6% in absolute terms during 2008. Technical Management training to suppliers.	Reduction the waste to landfill by 50% relative to sales by 2012, against a 2005/06 baseline. Reduce suppliers' travel by 5 million Km.	Achieved 18% of long term target.	Reduce volume of waste to landfill by 50% by 2010.	Considering the merger with United Co-operatives, the amount of waste re-used and recycled increased in 4,771 tonnes in 2007 against 2006 baseline.	Ensure that less than 50% of total waste arising is land filled by 2013
Food waste control	Delivery of surplus fresh food to homeless shelters in partnership with FareShare.	Use food waste for producing energy.	It launches initiatives to spread the utilisation of plastic bags made of recyclable materials.	Target zero waste to landfill by 2010.	A decrease of 6% in absolute terms during 2008. Technical Management training to suppliers.	Reduce the waste to landfill by 50% relative to sales by 2012, against a 2005/06 baseline. Reduce suppliers' travel by 5 million Km.	Achieved 18% of long term target.	Reduce volume of waste to landfill by 50% by 2010.	Considering the merger with United Co-operatives the amount of waste re-used and recycled increased in 4,771 tonnes in 2007 against 2006 baseline.	Ensure that less than 50% of total waste arising is land filled by 2013
Recycling facilities	Installation of 45 "reverse vending machines", which separate different kinds of materials and compact them ready to recycle, increasing the average of recycled materials from 4 to 8.3 tonnes each week.	It is planned install 100 machines by March 2009.	Using a backhauling process is recycling to some of 5 Asda Service Centres 65% of the stores' waste.	Goal, eliminate the remaining 35% of waste which is not currently reprocessed.	Increase to 50% of recycled material in the standard carrier from June 2008.	Drive down carrier bag usage by 50% by April 2009, against April 2008 baseline.	Recycled 72% of available store waste.	Increasing the proportion of recycled available store waste to 80% by 2010.	In 2007, almost 40,000 tonnes of waste was recycled or reused. 1,249 tonnes were through own recycling centre in Manchester.	Commit to increase in recycling facilities.
Packaging	Launch a system for registering suppliers' data online, which support packaging improvements. In 2007 own-brand packaging in electrical and clothing lines has reduced by as much as 40%.	Reduction in the packaging by 25% by 2010.	Reduction of 10% own label food packaging. Sourcing paper from sustainable forest, certified by Forestry Steward Council.	Reduction by 25% own label food packaging.	90% SO's (Sainsbury's Organic products) packaging will be recyclable, reusable or compostable. 75% of wood-based products have been certified by Forestry Steward Council.	Reduce the amount of packaging by 25% by May 2010, and 50% from this is hoped will be from recycled material on fruit and vegetables.	Achieved 44% of long term target.	Increase recycled content of standard plastic carrier bags to 50% by 2010.	In late 2007 was restated the target of 15% of reduction in packaging, including transit packaging.	Initiate projects to support reduction in primary packaging on own brand food products by 15% by 2010.
External factor	Progress with product carbon and labelling footprints.	Reduction of 50% CO_2 emissions[5] by 2020.	Commit to achieve Government's Courtauld Commitment.	Commit to use 18,000 tonnes each year less packaging.	New stores use green technology to recycle waste which provided energy. Reduce CO_2 emissions per case transported by 5% by March 2009 against a 2005/06 baseline.	Reduction CO_2 emissions per square metre by 25% by 2020.	Reduction of 10,818 tonnes of CO_2 emissions due to transportation efficiencies. And 58% road miles travelled per pallet of stock and 35% empty road miles travelled of target by 2010.	Save 8% haulage CO_2 emissions by 2010, against 2005 baseline.	Commit to reducing the carbon footprint.	An independent lifecycle analysis of common packaging options was conducted

[1] http://www.j-sainsbury.co.uk/cr/index.asp

[2] http://www.co-operative.coop/food/ethics/Environmental-impact/

[3] Total waste in UK was 487,000 tonnes.

[4] Most of the recycle wasted was cardboard and plastic. The target in 2007 to recycle was 75%.

[5] Target for worldwide operations. In UK the commitment is to reduce by 5.5 % in their existing stores and distribution centres.

3.2.7. What Happens to Waste

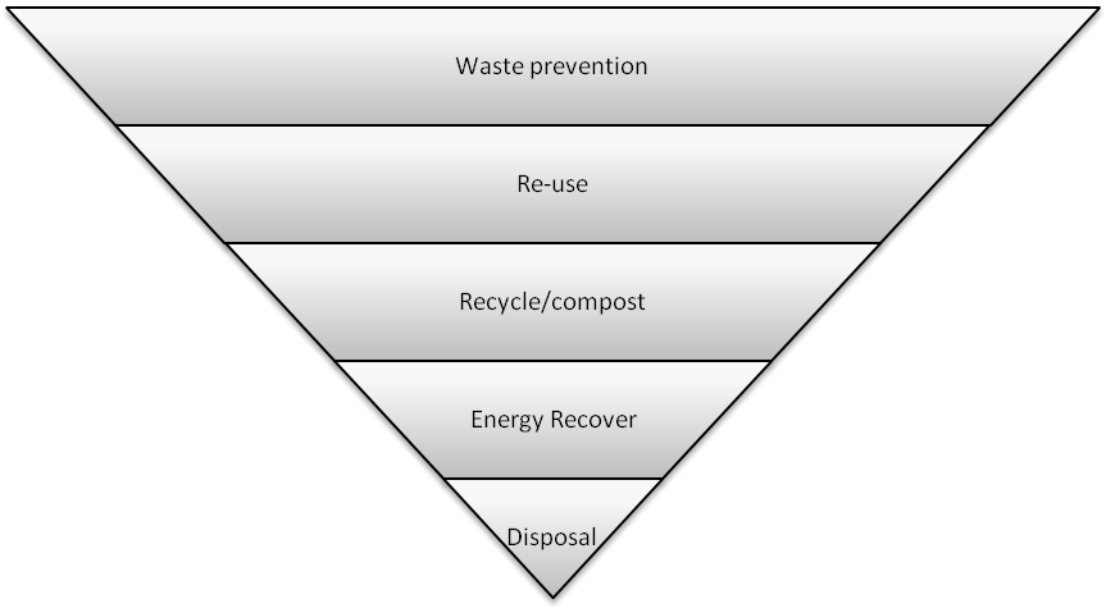
The waste management hierarchy (Defra, 2007b) gives industry a structure for the management options for waste. The options are as follows:

- Waste prevention
- Re-use
- Recycle
- Energy recover
- Disposal.

Figure 12 shows the relationship between the steps in terms of priority and ideal quantities, i.e. more waste prevention than waste re-use. Waste prevention aims to avoid producing waste in the first place and should be carried out ideally before any of the other solutions in the hierarchy. The main aim is to cut down waste going to landfill and to obtain the full potential from materials and foodstuffs rather than produce waste for the sake of it (Defra, 2007a).

For the food industry, general waste minimisation activities include improving operational practices, increasing control of existing waste operations and introducing innovative process technology (C-Tech Innovation Ltd, 2004). Implementing this step presents the challenge of investing money into operations. However, this investment will be recouped as other disposal methods, such as landfill and incineration, become more costly and deemed more environmentally damaging.

Figure 12: The waste hierarchy (Defra, 2007b).



Re-use of materials where possible is the next step. However, in the food industry there are barriers to applying this proposal. The limiting factor is generally hygiene requirements; for example, any re-use of packaging would require a high standard of cleaning before it can be re-used which is often not cost effective (C-Tech Innovation Ltd, 2004).

In terms of recycling and composting, the food production industry has a wealth of options available which include composting, land spreading and aerobic digestion. These can often lead to further income streams because the by-products can either be resold to food producers or re-used by the manufacturer in other operational procedures (Fellows, 2000).

Other options of waste disposal that would lie at the bottom of the hierarchy include incineration, rendering and landfill. Incineration is generally perceived by the public to be environmentally unfriendly and a health damaging method of disposing of waste which is surrounded by high levels of legislation and regulation. In other countries where technology for converting incinerated waste into energy has progressed substantially (where the conversion efficiency is approximately 75%) (C-Tech Innovation Ltd, 2004)) it is deemed to be a tolerable diversion route for waste from landfill. It should be noted that ultimately the resulting ashes are often land filled.

The rendering of animal by-products from the meat production chain is estimated to be a cost-effective means of disposal at least in the medium term due to the legislation mentioned previously in this report (UK Government 1999). It is estimated that 1.75 mt of this waste is to be dealt with annually which produces 0.25 mt of fat and 0.4 mt of protein meal through rendering (C-Tech Innovation Ltd, 2004).

Landfill is the UK's prevalent waste disposal route and handles 50% of industrial waste. There have recently been several drivers for change in the implementation of the waste hierarchy and to reduce this figure. These include categorising waste (into hazardous, non-hazardous or inert), reduction of active landfill sites and a ban on tyres going into landfill. Also to be imposed are the banning of liquids, the requirement of pre-treatment for non-hazardous waste (both from October 2007) and the planned closure of some landfills by 2009 (Defra, 2007b).

3.2.8. Causes of Waste

Waste is an undesirable effect resulting from the complex interaction of management practices, product characteristics, consumer trends and environmental factors. Incidents leading to food waste are seldom the result of a single cause but rather from a combination of factors occurring simultaneously. For instance, poor information sharing combined with a short shelf life chilled product and a spell of cold weather could lead to substantial amounts of waste due to the fluctuation in demand. Hence it is difficult to attribute specific amounts of waste to each cause. However, it is possible to identify those causes that appear to be having the most influence on waste. Table VIII presents a short description of the leading causes of waste in the food and drinks industry.

Table VIII: Causes of Waste

	Cause	Description
Management Factors	Forecasting	Estimating the demand for a product is a complex and inherently inaccurate activity which can be affected by many factors such as weather, seasonality, marketing campaigns, product launches, promotions and special occasions such as Christmas and Easter. Forecasting error has a direct impact on waste, particularly for products with short shelf lives. Hence the forecasting approaches and methods used by both retailers and manufacturers are key to reducing waste.
	Information sharing	Accurate and timely information is essential for good planning and forecasting. When information is scarce there tend to be large variations between forecast and orders which often result in waste. Furthermore, variations caused by poor information sharing can amplify across the supply chain (i.e. bullwhip effect).
	Promotions	Demand during promotional periods is notoriously difficult to forecast and the increased forecasting error is likely to lead to increased waste. Furthermore, promotions can also increase household waste as customers might buy unusually large quantities of product.
	Shelf life policies	Most mainstream retailers have policies of only accepting product with a high proportion of shelf life remaining (usually over 70%). This is particularly problematic for own label producers who are unable to sell the product through other channels, such as discount retailers.
	Inventory Management	Inventory management policies, particularly around safety stock levels are likely to have an impact on waste.
	Stacking and shelving	Stocking and shelving can have an impact on product damage but also on product selection by customers who will prefer those products with the longest shelf life available.
	Penalties and availability targets	Penalties are a mechanism used to ensure that deliveries are made on time and in full. However, they can encourage manufacturers to over-produce to cover themselves against the risk of penalties or de-listings.
Product Factors	Product characteristics	Some characteristics inherent to the product such as shelf life and temperature regime tend to generate waste. However, technology can be used to alter some of these characteristics.
	Packaging	Packaging plays a dual role in terms of waste; on the one hand it protects the product from damage and can help to extend its shelf life, having a positive effect on waste. On the other, the amount of packaging on a product has a direct impact on household waste and to some degree on waste generated at other stages in the chain.
	Product damage	Poor practices in product storage and handling, coupled with packaging and palletising practices, can result in damaged products which are discounted or discarded.
	Product recalls	Product recalls are relatively rare events. However, when they occur they are likely to generate large amounts of waste, particularly for products with long shelf lives since they are likely to have more stock in the pipeline.
Environmental and Consumer factors	Customer trends	Trends in customer demand can have a substantial impact on waste levels. Environmental trends, for instance, are already having a positive influence on the reduction of packaging waste. Other trends such as the increase in fresh foods and some convenience foods with short shelf lives can have a detrimental effect on waste.
	Weather	Weather patterns have a strong effect on demand for some products, particularly fresh produce and beverages which are likely to affect waste levels. Although these events are beyond the control of the companies involved, actions taken to monitor and react to changing weather patterns could help to minimise waste.
	Catastrophic failures	Temperature controlled supply chains suffer the risk of a potential catastrophic failure in warehousing or transportation equipment. Although these events are rare, their impact is bound to be substantial in terms of the volume of waste generated.
	Seasonality	Seasonality of both supply and demand affects forecast accuracy, production levels and inventory levels. All of these factors could lead to waste.

3.2.9. Technologies in Food Supply Chain

Short shelf life chilled food stuffs pose the greatest challenge for retailers and suppliers in terms of food waste reduction and consumer satisfaction. Consumers are demanding fresher produce with a longer life time but with reduced amounts or even no use of preservatives. With retailers, supplier and manufacturers the problem is with the agility of the supply chain and process that can allow these goods to be produced and sold without waste in the process.

The goods that are of most concern in this section are perishable and delicate food stuffs, such as, meat and fish, fruits and ready meals including sandwiches. These goods require constant temperature management as well as careful handling and robust packaging. The role of food packaging within the food and drink industry is currently under review, with many food retailers pledging to reduce the amount of food packaging used. Food packaging has four key purposes and these are:

- To protect the contents
- To contain the contents
- To communicate with the user
- To be convenient for the user

Refrigeration in food supply chains is used to slow the rate at which changes occur in food. These changes are summarised in Table IX.

Table IX: Possible changes of food as it degrades

Change	Effect
Microbiological	Growth of microorganisms
Physiological	Ripening
Biochemical	Browning reactions and fat oxidation
Physical	Moisture loss

Efficient refrigeration of a cold chain prevents these changes occurring for as long as possible, facilitating the production of safe food with a long shelf life and of high quality. There are many available technologies to counteract these changes. All of the current techniques involve the removal of heat energy from the product to retard any product damage. The main concerns of technology and packaging in this sector are for the protection and containment of the food stuffs.

The safety and spoilage of food is counterbalanced by the requirement of stored food stuff to be of a certain nutritional and visual quality. Over refrigeration of foods can result in direct loss of nutritional value and taste quality, and can damage or bruise certain foods. Failure of cooling equipment to suppress these changes can arise from the following:

- Insufficient time allowed to cool/remove heat
- Insufficient refrigeration capacity in the equipment to deal with the initial product load

- Over loading of refrigeration units
- Variability of product size/weight
- Incorrect conditions used for product.

The three factors that affect the storage life of a product include the storage temperature, the fluctuation of that temperature, and the type and amount of packaging used to store the food.

There is also a branch of emerging technology that aims to monitor food change. The technology that will be discussed will be around the issues of improved communication of the packaging for the user and improved protection of the food stuffs from the external environment.

Active packaging is defined as 'packaging in which subsidiary constituents have been deliberately included in or on either the packaging material or the packaging headspace to enhance the performance of the packaging system' (Robertson, 2006), The interaction of the active features can be through a chemical (modified atmosphere) or biological (antimicrobial agents) interface to provide an extended shelf life or an addition to the packaging that enhances its performance.

Examples of active technologies used in packaging are shown in table X. As previously mentioned, the underlying function of these technologies is to protect and increase the longevity of the product within the packaging. The examples given in the table act to preserve and protect the food product so that it is able to maintain the desired flavour and customary appearance through delaying or hindering bacterial spoilage. This is achieved by modifying the atmospheric conditions of the packaging or by changing the surface of the packaging.

Table X: Examples of active packaging applications in the food industry (Adapted: Kerry et al., 2006)

Absorbing/scavenging properties	**Oxygen, carbon dioxide, moisture, ethylene, flavours, taints, UV light**
Releasing/emitting properties	Ethanol, carbon dioxide, antioxidants, preservatives, sulphur dioxide, flavours, pesticides
Removing properties	Catalysing food components removal: lactose, cholesterol
Temperature control	Insulating materials, self-heating and self-cooling packaging, microwave susceptors and modifiers, temperature-sensitive packaging
Microbial and quality control	UV and surface treated packaging materials

Smart or intelligent packaging is a widely used term that often covers many different branches of technology and packaging design. Although there is no formal academic definition for the terminology "*smart/intelligent packaging*", many agree that it can be defined as any packaging that goes beyond the use of simple materials in conjunction with printed barcodes or labels (Kerry and Butler, 2008). The term intelligent packaging is often used to describe improvements in existing materials or methods to extend shelf life by preventing microbial growth (Coma, 2008; Sivertsvik et al., 2002). Intelligent packaging is also used to illustrate

additional design features to packaging that are convenient and that may enhance the usability of a product.

The less stringent definition of intelligent packaging allows for a greater scope of technologies and products. Table XI summarises the main ideas around this topic of research and proposes potential or available technologies that could be used.

Table XI: Examples of intelligent packaging in the food industry (Adapted: Kerry et al., 2006)

Tamper evidence and pack integrity	Breach of pack containment
Indicators of product safety/quality	Time Temperature indicators (TTIs), gas sensing devices, microbial growth, pathogen detectors
Traceability/anti-theft devices	Radio frequency identification (RFID) labels, tags, chips
Product authenticity	Holographic images, logos, hidden design print elements, RFID

As with all new technologies, there are inherent problems with the introduction of smart and intelligent packaging systems. Table XII shows the potential barriers and challenges to be overcome when introducing packaging technology to be used by the general public.

Table XII: Problems and solutions encountered with introducing new products using active and/or intelligent packaging techniques (Adapted: Hurme and Ahvenainen, 1996)

Problems	Solutions
Consumer attitude	Consumer research: education and information
Doubts over the performance	Storage tests before launching; consumer education and information
Increased packaging cost	Use in selected, high quality products; marketing tool for increased quality and QA
False sense of security, ignorance of date markings	Consumer education and information
Mishandling and abuse	Active compound/sensor incorporated into label or packaging film; consumer education and information
False complaints and returns of packs with indicators	Indicator automatically readable at the point of purchase
Difficulty of checking every indicator at point of purchase	Bar code labels: intended for QA for retailers only; RFID system within stores

The effective improvement in food monitoring may only be observed in chilled goods with very short shelf lives. The ongoing issue is with equipment failure within these chains and the amount of product that is wasted when a catastrophic failure occurs. These technologies will only allow a user to know when and where a cold chain is failing and will not aid in predicting, or preventing a refrigeration unit from, failure or power loss.

RFID has long been heralded as 'the next big thing' in supply chain management and as the solution to many inventory management problems. In this section, a consideration of a system that has benefited from RFID (radio frequency identification) tags technology will be discussed. This section is not intended to discuss the technology in detail, because an excellent overview has been written elsewhere which explains the workings and limitations of the technology (Clarke, 2008).

RFID permits the transfer of electronic data and therefore is classified as a separate intelligent device and does not fall into either the sensor or indicator categories. The concept is that tags are attached to items (ranging from cattle, containers, pallets, individual packets etc.) to give the user a real-time collection of data, which is then transmitted to an information system for analysis and tracking. For some, RFID technology is seen as the natural evolution of the barcode in that it gives objects identification as well as a potential array of other information. Some of the benefits of RFID in food supply chains include:

- Improved store service
- Product visibility
- Inventory accuracy
- Improved processes

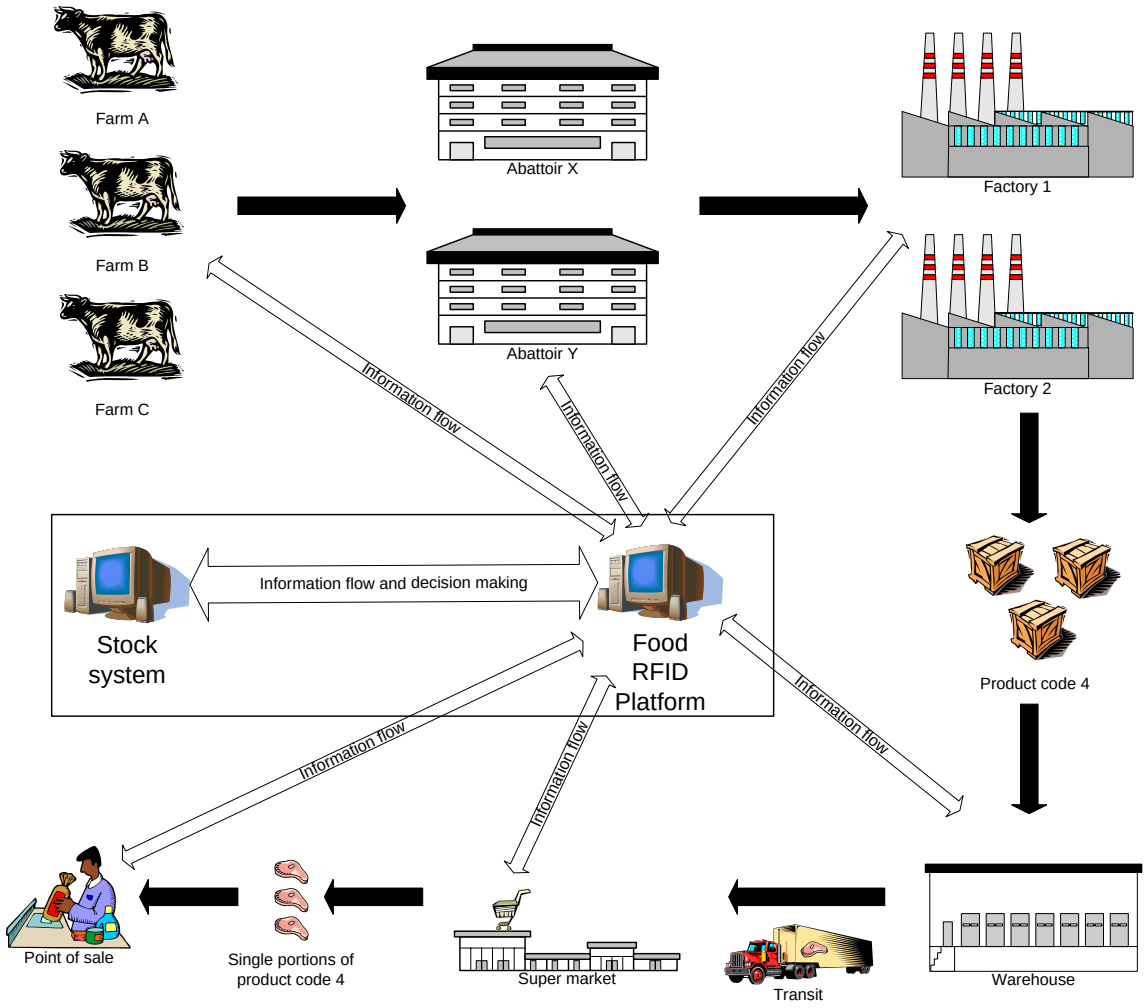
The intelligent label to be used as a food monitoring device would need to be able to communicate with the user at any point to highlight any problems. This is a potential hurdle in the light of recent bad press that RFID has received for being an intrusive technology into consumer privacy. Another problem is the cost of an integrated label that would require adequate power to monitor food and signal any problems if necessary. This would require a reliable power source and could place the cost of the technology out of the range of potential users.

It is often said that retail is detail. RFID technology in the first instance acts as a descriptor of what it is attached to. Consider a plastic tray in a food depot containing packaged portions of chicken breast; a written tag on the side of the tray would be able to confirm what the contents were and a few more key pieces of information (weight, date and place of origin etc.) which would then be manually entered onto a stock management system. A barcode could provide a method of relaying this information, and maybe more, to a stock management system. If a real time device, such as an RFID tag with an attached Food Quality Indicator (FQI), were to be attached to the tray then much more information could be ascertained. This information could include more data on the source of the meat, the route so far taken by the tray through the supply chain pipeline, the predicted shelf life remaining of the meat and so forth.

For many, the idea of an RFID tag attached to an individual item for the purposes of stock management in the food industry is complex and expensive. If the tag were to

provide more information about the remaining shelf life and possible contamination, then the cost and information trade-off would be better balanced. Figure 6 shows a simple model of a supply chain using RFID technology in conjunction with an FQI tag. Upon entry and exit of every stage of the diagram, the RFID chip is updated with information about where it has been; a remote reading could be taken of the state of the food stuff that is attached.

Table XIII: A simplified map of a supply chain and how an intelligent tag could be used for stock control and product monitoring (adapted from (Stafford, 2008)).



Following this simplified diagram, a generic meat product (here named *product code 4*) is followed from producer to point of sale. The emphasis here is on the different routes the product could take through a supply chain and on the breakdown of the original product to the final finished product. The wealth of information that could be obtained from a system like this would help to find weaknesses in efficiency throughout the chain as well as help manage inventory levels and supply. Adding to an existing RFID framework, a sensor to estimate product safety and condition would facilitate stock management decisions.

3.3. Supply Chain Initiatives in the Food & Drink Industry

New tools and technologies are continuously being developed and promoted by consultants, software suppliers and other service suppliers in the industry, and it is important to be aware which the main trends are and how they are expected to evolve. This section reviews some of the major supply chain management trends affecting the food and drink industry, focusing in particular on technology-related issues.

3.3.1. Collaborative Planning, Forecasting and Replenishment (CPFR)

Collaborative Planning, Forecasting and Replenishment (CPFR) is a set of business processes that can help to improve collaboration and efficiency in a supply chain. The core objective of CPFR is to increase the accuracy of demand forecasts and replenishment plans, helping to reduce inventory and increase service levels.

CPFR is the latest in a series of initiatives that focus on collaboration and trust between partners in the supply chain, such as Efficient Consumer Response (ECR), Quick Response and Vendor Managed Inventory (VMI), which will be discussed later in this document. The first CPFR project took place in 1995, involving five companies, Warner-Lambert, Wal-Mart, SAP, Manugistics and Benchmark Partners (Barratt and Oliveira, 2001). However, the first document on CPFR, the "VICS CPFR Guidelines" (VICS, 2008), was not published until 1998.

The general process for achieving CPFR is depicted in Figure 13, showing the main stages and the activities at each stage, illustrating how the collaborating partners interact throughout the process. A brief description of the stages, based on the CPFR Guidelines (VICS, 2008), is presented here:

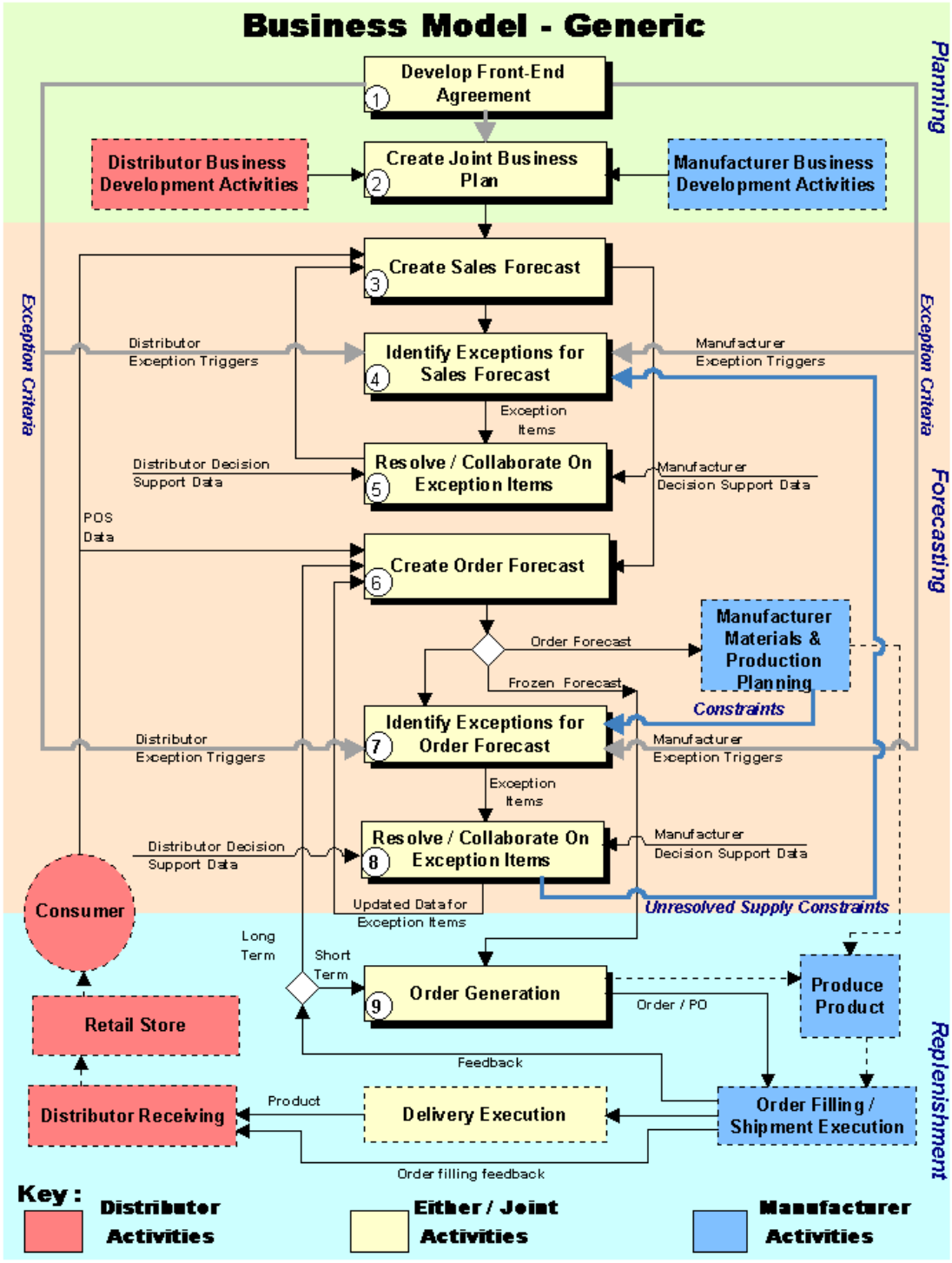
a) Planning

An agreement is established between trading partners to develop a market-specific plan based on category management principles. A key to success is that both partners agree to own the process and the plan, and share responsibility. This plan describes what is going to be sold, how it will be merchandised and promoted, in what marketplace, and during what time frame. Each partner uses their own Enterprise Resource Planning (ERP), Supply Chain Management (SCM), Demand Planning and forecasting system to make the plan operational, however, VICS communication standards are used to share relevant information.

b) Forecasting

The forecasting stage is divided into two main segments, sales forecasting and order forecasting. Both of these forecasts are produced based on a number of inputs such as Point of Sale (POS) data, causal information and information on planned events. At the end of both the sales forecasting and the order forecasting stages, any constraints or exceptions are resolved jointly by querying shared data, or by using email, telephone and face-to-face meetings. Forecasts are updated after resolving any existing conflicts. With CPFR, a forecast can also become frozen in advance, and can be converted automatically into a shipping plan, avoiding the customary order processing.

Figure 13. CPFR Generic Business Model (Source: VICS, 2008)



c) Replenishment

This final step marks the transformation of the order forecast into a committed order. Order generation can be handled by either the manufacturer or distributor depending on competencies, systems and resources (VICS, 2008).

A number of benefits have been claimed about CPFR. However, being a relatively new initiative most of these claims have not been proved. Table XIV shows some of the expected benefits from CPFR, as well as some of the possible limitations.

Table XIV: CPFR Benefits and Limitations

Benefits	Limitation
• Improve forecast accuracy • Reduce inventory levels (through visibility) • Improve service levels • Increase sales • Reduce administrative errors and duplicated effort • Reduce / eliminate reactive behaviour 'fire-fighting' • Improve Technology Return on Investment (ROI) • Improve overall ROI	• High investment in IT (in both capital and human factor) • Might involve substantial changes to operational processes • Perceptions differ between manufacturers and retailer • The initiative is relatively new and there is no statistical "proof" about the expected benefits.
Sources: Barratt and Oliveira, 2001; VICS, 2008; Stank et al., 1999.	

3.3.2. Efficient Consumer Response (ECR)

Efficient Consumer Response is a grocery industry initiative in which the members of the supply chain work together with the aim of fulfilling consumer wishes better, faster and at less cost (ECRE, 2008).

ECR first began in the United States in 1992, as a response to economic and consumer pressures and in Europe started to attract attention in 1994, with the formation of ECR Europe (www.ecrnet.org). In the UK, the initiative was formed in 1996 with the purpose of developing an industry approach to creating a more efficient supply chain focused on the consumer.

The main difference between ECR and some other logistics initiatives – such as Quick Response and Continuous Replenishment – is that it does not only focus on the replenishment process, but also considers product development, promotions and assortment as essential business processes in the industry. These four processes are the main pillars of ECR, as shown in Table XIV.

Table XV: ECR Pillars

Pillar	Strategy	Activities
Efficient store assortment (ESA)	Providing a complete easy-to-shop, assortment of products wanted by the consumer, focusing on the demographics of the catchment population.	Manage product categories Manage store operations Service customers
Efficient replenishment (ER)	Maintaining high in-stock levels of the required assortment, while increasing inventory turns.	Manage store orders Manage customer orders Procure materials Procure products Store and stage products Deliver products Manage inventories
Efficient promotion (EP)	Harmonising the promotion activities between manufacturer and retailer by communicating benefits and value, avoiding excess inventory.	Consumer advertising Store advertising Consumer promotions In-store promotions Customer deals
Efficient product introduction (EPI)	Developing and introducing new products as required by the customer, as well as reducing product development cycles.	Conduct basic research Develop new products
Sources: Cerovic, 1998; Brokman and Morgan, 1999		

In order to manage the activities in the four different pillars, ECR exploits a number of management tools and techniques that have been available for some time, such as continuous replenishment, quick response, co-managed inventory, cross docking, activity-based costing, value chain analysis, third party logistics and scorecards (Cerovic, 1998). In terms of the technology, ECR also uses a number of readily available technologies such as EDI, warehousing technology, computer aided ordering (CAO), advanced shipping notices (ASNs), flow of funds, EPoS and data warehousing (Cerovic, 1998).

Efficient Consumer Response promised many benefits. However, a number of barriers and limitations have also been reported. Table XVI captures some of the main benefits and limitations of ECR.

Table XVI: CPFR Benefits and Limitations

Benefits	Limitations
• Better responsiveness to consumer needs • Faster growth • Enhanced margins • Improved product ranges • More effective use of promotional activity • Lower levels of stock • Greater synchronisation of production • Increased integration across the supply chain • More rational use of resources • Positive environmental impact • Different approaches can be implemented separately	• Trust between partners is essential for successful implementation • There is an uneven distribution of benefits, costs and risks between partners in the supply chain • Relatively high complexity in implementation • Trials require considerable investment • High integration required for product introduction and promotions • Not broadly accepted in the industry
Sources: Brokman and Morgan, 1999; Kotzab, 1999	

3.3.3. Vendor Managed Inventory (VMI)

Vendor Managed Inventory (VMI) is a means of optimising Supply Chain performance in which the "supplier" is responsible for managing the customer's inventory levels and decides how and when to replenish materials without the need for a purchase order. The exact degree of responsibility in the relationship depends on the agreement between the partners. However, other similar approaches such as Supplier Managed Inventory (SMI), Co-managed Inventory (CMI) and Jointly Managed Inventory (JMI) denote a more collaborative relationship than VMI and might require customer agreement or joint planning and forecasting.

The main activities in VMI are the responsibility of the supplier. However, it is the responsibility of both partners to set up the agreement. The IGD suggests a 10-step process to set-up a VMI agreement – see Table XVII.

Vendor Managed Inventory is one of the most accepted techniques in the industry; a survey by Tompkins Associates revealed that 76% of the surveyed companies were involved in VMI at least with some customers (Tompkins Associates, 2001). This same research showed that respondents felt in general that VMI was delivering solid benefits to the organisation. Table XVIII shows some of the main benefits that VMI can bring to the organisation, along with some of its limitations.

Table XVII: VMI Implementation

Step 1	Management Sponsorship	VMI must have senior management endorsement and be identified as a strategic objective. There must be widespread awareness of the costs involved, manpower requirements and cultural changes.
Step 2	Employee Training	A wide range of employees must accept and contribute to the changes required – not just those directly responsible for managing stocks.
Step 3	Synchronise Files	The supplier's master product data is matched with the customer's. Any changes to the product catalogue must be communicated between VMI partners.
Step 4	Testing	Partners validate that data is being property sent / received. This may take many tries and adjustments before final validation
Step 5	Agree Methods & Measurements	The companies agree the operational ground-rules, e.g. frequency of deliveries. This will incorporate targets such as inventory turns, fill rates and service levels.
Step 6	POS History	The customer sends the manufacturer the Actual Sales file, usually 1-2 years history. This will incorporate targets such as Inventory Turns, Fill Rates and Service Levels.
Step 7	Live Status	The customer records the sale of each product via an EPoS system and provides the supplier with access (normally by sending a batch file). As soon as a minimum reorder point is reached, the supplier creates a replenishment order. If the demand pattern is expected to vary, e.g. because of seasonality or promotions, the order is adjusted.
Step 8		The customer receives acknowledgement of this order and has the opportunity to communicate changes to the supplier
Step 9		The supplier picks and packs the order and sends an advanced delivery notification to the customer
Step 10		Upon delivery the customer confirms receipt of the products. However, in some cases, this step is bypassed and the supplier is paid only once products are sold to a shopper.
Source: Institute of Grocery Distribution (IGD)		

Table XVIII: Vendor Managed Inventory - Benefits and Limitations

Benefits	Limitations
• Fosters co-operation • Lower cost for retailer • Lower distribution costs • Lower selling costs for suppliers • Lower overall supply chain costs • Improved availability • Higher sales	• Higher overall costs for suppliers • Culture change required • Retailer loss of control and flexibility • Blurred responsibilities • May promote supplier-push behaviour • Data errors • Volume reduction for suppliers
Source: Institute of Grocery Distribution (2007)	

3.3.4. Other initiatives

The initiatives that have been described in the previous four sections are only some of the most publicised in the industry. However, there are many other strategies, tools and techniques that are being discussed and implemented. Table XIX shows some more initiatives that have received attention in the industry.

Table XIX: Trends in the Food and Drink Industry

Trend	Description
Category Management	The strategic management of product groups through trade partnerships.
Continuous Replenishment (CRP)	The replenishment of products to target inventory levels of trading partners using consumer demand data, promotional plans and warehouse stock information.
Quick Response (QR)	System for reducing lead time and increasing delivery frequency so that product supply is more closely based on actual consumption at the retailer rather than forecasts.
Customer Relationship Management (CRM)	A technique used to understand customers better in order to acquire, retain and grow accounts with those that are most profitable. Data collected through CRM enable firms to differentially serve target segments, including tailoring products to include features valued by those segments, and excluding features that add cost but fail to significantly influence target customer purchases.
Warehouse Management Systems (WMS)	Computer systems that handle warehouse operations such as order generation, assembly, dispatch and labour management. The main goals of WMS are to reduce inventory levels and improve pick rates.
Computer Aided Ordering (CAO)	Automated ordering systems that use EpoS data rather than warehouse data to generate orders. They have been designed to facilitate continuous replenishment.
Advanced Ship Notices (ASN)	Notify the retailer that a particular shipment is on its way. This allows the retailer to measure inventories in advance and plan for its next order.
Sources: Cerovic, 1998; Brokman and Morgan, 1999	

4. Methodology

The overall aim of this project was to provide a qualitative analysis of the food and packaging waste arising from the link between food manufacturers and retailers in the UK. Contributing to this aim there were four specific objectives:

- To identify the main root causes of food and packaging waste in the supplier / retailer interface
- To assess the prevalence and magnitude of each of the root causes identified
- To identify good practices and examine the enablers and inhibitors to their implementation
- To provide recommendations for policy and practice that will help the food and retail industries to jointly address the root causes of waste.

4.1. Research design

The food supply chain covers a wide range of products with different characteristics such as shelf life, temperature regime and demand variability and the research methodology selected should be able to cater for this diversity. Furthermore, the project requires the analysis of quantitative data, to estimate the magnitude of the problem, and qualitative data to understand the causes and potential solutions. This context calls for a research methodology that can study contemporary events from different perspectives and is adaptable to many different situations.

Based on the objectives of the project and on the characteristics of the food sector mentioned above, it was decided to use a multiple case-study research design. In this instance the unit of analysis is a product or product category flowing between a manufacturer and a retailer. This focus allows an understanding of the issues emerging between the two parties and, more importantly can lead to solutions that are acceptable to both.

In the original research design we aimed to conduct 16 cases covering a range of product types across different temperature regimes: frozen (3), chilled (5), ambient short shelf life (5), ambient long shelf life (3). This approach allowed the research team to understand the factors affecting different types of food chains. The actual number of cases conducted was 20 although the balance of cases shifted slightly during the process. As the cases were conducted it became apparent that the biggest issues in terms of waste appear in products that have short shelf lives and are often chilled. For this reason it was decided to increase the number of cases in chilled from 5 to 10 and decrease the number of cases in frozen from 3 to 2. The number of cases for ambient products was conducted as planned. Table XX presents the comparison of actual and planned cases by product category.

Table XX: Case Studies (Planned vs. Actual)

	Cold Chain		Ambient	
	Frozen	Chilled	Short shelf life	Long shelf life
Planned	3	5	5	3
Actual	2	10	5	3
Examples	Ice-cream, frozen veg.	Meats, dairy, drinks, sandwiches	Fruit and vegetables	Confectionery, canned & bottled product, oil

4.2. Data collection

The case studies involved three forms of data collection: (1) semi-structured interviews, to understand the issues and causes of waste; (2) company records, to estimate the amount of waste; and (3) process observation, to understand the physical and information processes in the chain. The interviews and observations aim to collect quantitative and qualitative data which will help to define the magnitude of the problem and identify its causes. It must be noted that it was not possible to conduct all three forms of data collection for all cases. In 17 of the cases it was possible to use at least two of these methods. The remaining three cases were conducted through a workshop in which suppliers of produce to one retailer discussed the issues and completed a form based on the interview questionnaire.

The main data collection method was the semi-structured interview, which lasted around 1 hour and was conducted by two members of the research team. Most of the interviews were conducted face to face, although on two occasions it was necessary to conduct them over the phone due to the long distances involved.

Interviews were conducted with managers responsible for waste in their respective organisation. In some organisations there was no specific waste management role and in these cases we interviewed managers with supply chain responsibilities.

The interview protocol was developed in three stages. A first draft was prepared by one of the researchers; this draft was reviewed by all members of the team and adapted based on their feedback. The second draft was piloted in the first two cases after which it was decided to include only one additional question (the final interview protocol is included in the appendices). The interview questionnaire covered four key:

- Contact details and demographic: covering details about the company and the product under review.
- Quantitative waste data: specific data concerning waste volumes and percentages
- Causes of waste and good practices: discussion on the main areas of waste
- Destination of waste: discussion of how waste is managed

From the beginning of the project it became evident that waste information was considered as sensitive by many organisations. For this reason a confidentiality agreement was offered to all participating companies. Many of them decided to sign this agreement, but some were satisfied with a verbal agreement that data would be treated confidentially. Likewise, some of the companies participating in the study were willing to provide us with quantitative data about the levels of waste in their organisations, while others preferred to focus on the qualitative elements of the research (causes of waste and good practices) without revealing specific waste figures.

To ensure the data collected were an accurate reflection of what was discussed during the interview, a case study report would be sent to the companies involved a few days after the interview. The companies then verified the accuracy of the data and often included additional data that were missing during the interview process.

Observations and company records were used as secondary methods of data collection and were applied selectively according to the situation. In some companies it was difficult to have a complete observation of the process since this was distributed across different sites (depots, stores, pack houses, etc). Waste records were requested during the interview; however, some companies did not have waste records or were unwilling to provide them.

4.3. Data analysis

The focus of the project was on the causes and best practices around waste management which are best suited to qualitative data analysis approaches. Initially case studies were analysed independently; data for each of them were coded and put into a standard case-study template. Following the single case analysis, key information ware extracted to produce tables to facilitate cross-case comparison. Then these data ware analysed in three ways:

- Analysis of waste by product types: products were grouped by temperature control in order to analyse the key issues for each product grouping.
- Analysis of root causes: a method using current reality trees (CRTs) was used to analyse the complex set of causal connections leading to waste.
- Analysis of good practices: this was done by focusing on the promising practices documented in each of the cases and trying to identify patterns across the cases.

The aim of this project was not to produce a statistical analysis of waste in the sector and for this reason statistical tools were not applied.

4.4. Validity, reliability and generalisability

A number of tactics have been followed to ensure that the research is valid, reliable and that it can be generalised to other fields. These tactics are:

- Replication and use of multiple sources of evidence (interviews, records, observations)
- Researcher triangulation (two researchers involved in collecting and analysing data)
- The use of a structured selection approach for the case studies
- The development of a case study protocol and a case study data base
- The use of structured data collection mechanisms through semi-structured questionnaires

5. Findings and Discussion

5.1. Case study summaries

This section outlines each of the responses and major causes of waste that arose directly from the interviews with each of the participants of this project. There will be a brief summary of each case and the problems/issues that were conveyed by the interviewee. The information portrayed differed in each case due to sensitivity and availability of data.

The case studies have been grouped according to the way the data was collected, so for instance if a number of cases were conducted with one retailer, they will be presented together, contrasting the general issues concerning the retail operation and the specific issues of each of the products. For future reference the case studies have also been numbered and coded according to temperature regime, using F for frozen products, C for chilled and A for ambient.

5.1.1. Retailer focused cases – F1, C1, A1

The first set of case studies to be presented involved a large food retailer. The food stuffs that were identified for analysis were potatoes (ambient), vegetables (frozen) and milk (chilled). The following table presents the quantitative data for all three cases

	Frozen Vegetables F1	Chilled Milk C1	Ambient Potatoes A1
Shelf life	6 months	3 days	3 – 5 days
Orders	Day 1 for delivery to RDC and store day 3		
Demand	Regular profile with sales uplift in Winter and reduction in Summer	Predictable footfall product	Regular profile with sales uplift in Winter and reduction in Summer
Stock	Depot 7 days, store 7 days	Depot 1.5 days, store 1.5 days	Depot 1.5 days, store 1.5 days
Waste in store	0.12%	0.1%	low
Responsibilities	Commercial teams have lead responsibility for waste. Store managers and replenishment teams also have targets for waste		

From the analysis with the retailers, it was concluded that some of the causes of waste tended to be general, across all product categories and some are specific to certain product ranges. Below we discuss the main general causes of waste, followed by specific causes for each of the products.

- Promotional Planning – The retailer runs promotional campaigns focusing primarily on price and in-store displays (BOGOF promotions are generally not used). Promotions management is decided by the retailer and promotional forecasts are not shared with suppliers. This is for commercial reasons. Sales

uplifts for products on promotion can be inaccurate. If the promotion outperforms it impacts on the sales of other products in the category and can lead to waste for these products (rather than the product on promotion). If the promotion underperforms, the promotion is continued (for a longer period or with a deeper price cut for example) with the result that waste does not arise.

- Forecasting - The retailer uses the Inventory Forecasting and Replenishment Module (INFOREM) to forecast demand, which is a tried and tested software tool. Critical factors included in INFOREM are 'De-seasonalised Demand' (DD) which reflects the average weekly sale of an item and the 'Profile' which represents the week-to-week changes in demand (seasonality). The profile and DD are multiplied together to create the weekly forecast. INFOREM generates orders when available stocks fall to a determined 'order point'. The 'order point' reflects lead time, seasonality and other factors. All the retailer's suppliers have access to sales information for their products. Although forecast accuracy can be affected by a wide range of factors it is not a cause of waste for this product (other than when the product is on promotion).

5.1.1.1. Frozen Vegetables (F1)

This product has a very low level of waste due to long shelf life of product and predictable demand. Seasonal and brand promotions impact on waste but are not significant due to long shelf life. New lines, new stores and new layouts in store can also lead to waste but are not significant. The current economic downturn is leading to an uplift in sales for these products, but it is unlikely to affect waste.

The main causes of waste for this product are:

- Intermediate and product packaging – Poor packaging is the most prevalent cause of waste which results in product being damaged in depot or store Product packaging is generally mixed plastics (which are not currently re-cycled) and can be damaged by handling operations. This damage is the prime cause of waste for this product
- Storage and in-store display – About 25% of waste is caused by catastrophic breakdown of refrigeration equipment; these incidents are rare but have a very high impact on waste. The retailer currently uses 3 temperature regimes in their depot but it is likely that they will be reduced to 2.

5.1.1.2. Chilled Milk (C1)

Despite its short shelf life and the requirement of a chilled supply chain, this product has a very low level of waste which is a function of predictable and constant demand. Promotions for this product are infrequent and do not lead to waste. The most prevalent causes of waste are:

- Storage and in-store display – Poor handling along the chill chain, for example, dropped product and leakages are the main cause of waste for this product but are uncommon. The product is stored in 'moveable dollies' which

aim to facilitate ease of handling and movement both within depot and store. Empty dollies are replaced throughout trading.

- Shelf life – The product has a short shelf life in store. The retailer seeks to maximise the shelf life available to customers by efficient handling through the chain and by reducing the time from ordering to delivery at store.

5.1.1.3. Ambient Potatoes (A1)

This product has a low level of waste. The most prevalent cause of waste across the 'category' is inaccurate forecasting when a product outperforms on promotion. Handling can lead to product and packaging damage which results in waste. The product is promoted on a seasonal basis, generally at the start of the new season.

- Storage and in-store display – Waste could arise if there is a mismatch between the amount of shelf space allocated and the available product. If insufficient shelf space is allocated when a product is on promotion it could remain unsold. Category planning teams at the retailer aim to allocate appropriate shelf space to individual products. Shelf fill is generally done overnight. Exceptionally poor handling can lead to damaged product and waste.
- Shelf life – The product has a short life in store. The retailer seeks to maximise the shelf life available to customers by efficient handling through the chain and by reducing the time from ordering to delivery at store.

5.1.2. Integrated retailer cases – A2 and C2

These two case studies involved a UK retailer with a degree of vertical integration across its supply chain. This integration allowed them to clear visibility of the supply issues, particularly for red meat and certain fruits and vegetables. As a result it was decided to focus the analysis on two products groups: fruit and vegetables (ambient) and red meat (chilled).

	Ambient Fruit and Vegetables A2	Chilled Red Meat C2
Shelf life	Variable	7 days
Orders	Day 1 for delivery to store day 2	
Demand	Predictable with seasonal variations	
Stock	1 day	
Waste in store	Varied but low	

There is a long standing business culture of cutting out waste at all opportunities. The retailer is vertically integrated and owns both abattoirs (3 in total) and a production facility. Whole animals (cattle, pigs, sheep) are purchased by the retailer. This has the effect, amongst other things, of minimising store waste. About 45% of the carcass is used for fresh and processed meat products. The

remainder of the carcass is used to produce a variety of products generally after rendering. At the retail end, maximum use is made of the carcass for fresh and processed meat products.

The retailer also owns 8 pack houses that handle a range of vegetables and fruit. For a given product the retailer purchases the whole crop. This has the effect, amongst other things, of minimising store waste. Stones, mud and damaged product are sifted out in the field. The remaining product is trimmed, washed and graded at the retailer's pack houses. All products are sold by the retailer (regardless of size or shape) in a variety of different ways (for example and depending on the product, items could be sold individually or in special bags). All trimmed material is used for animal feed.

If it is not recycled, waste currently goes to landfill, but they are presently conducting a trial using anaerobic digestion at one of their sites.

The general causes of waste for both products are:

- Forecasting and ordering – Ordering and forecasting are managed centrally but can be flexed by store managers. All orders are confirmed by 1100 hours based on historical sales patterns (the previous week and the same week in the previous year) factored centrally by seasonal events and the weather. Store managers confirm the order and if required flex the order based on counts of store and shelf stock. All deliveries are made direct to store the following day. The ordering/forecasting computer systems are currently being upgraded
- Shelf Life – Both of the products have a short shelf life in store. The retailer seeks to maximise the shelf life available to customers by efficient handling through the chain and by reducing the time from ordering to delivery at store.

5.1.2.1. Ambient fruit and vegetables (A3)

This product has a very low level of waste which is a function of the very short lead time which itself reflects vertical integration in this chain. Produce is regularly promoted, but waste does not generally arise from promotions because availability can be sacrificed. Promotional planning is also visible through the chain because of vertical integration. The main cause of waste for this product range is:

- Storage and in-store display – Vegetables and fruit are displayed at ambient temperatures. The retailer is conducting trials that involve packaging vegetables either individually or in other ways to protect from damage and extend the product life. It appears customers are choosing in favour of wrapped products.

5.1.2.2. Chilled red meat (C3)

This product has a low level of waste which is partly a function of the very short supply chain due to its vertical integration in this case. Meat products are regularly

promoted though generally customers are limited to a specific quantity but waste does not arise from promotions because availability can be sacrificed. Promotional planning is also visible through the chain because of vertical integration. The main cause of waste for this product is:

- Storage and in-store display – The main cuts of meat are prepared in-store and displayed. Although the product lasts longer when it is cut in-store it does not have the benefits of packaging technologies that can extend product life once it has been cut.

5.1.3. Retailer - Supplier cases – F2, C4 and A4

The next set of three case studies involved a large retailer in conjunction with a large supplier. All of the products analysed were manufactured by the same firm and sold by the same retailer. The products included luxury brand ice cream (frozen), margarine spread (chilled) and glass jars of pasta sauce (ambient). The parametric data for each of the products is presented in the table below, followed by a discussion on the causes of waste.

	Frozen luxury Ice Cream F2	**Margarine Spread C4**	**Ambient Pasta Sauce A4**
Shelf life	18 months	8 weeks	9 months
Orders	Day 1 for delivery to RDC and store day 4		
Demand	Highly seasonal and weather dependent	Regular profile	Regular with seasonal variations
Stock	Depot stockless, store 7 days	Depot stockless, store 7 days	Depot 4-7 days, store 7 days
Waste in store	1.1 % throughout store		
Responsibilities	Store manager is responsible for all store waste, depot manager is responsible for all RDC waste and category manager is responsible for all suppliers' waste.		

The general causes of waste across all products include:

- Promotional Planning – There is an agreed promotional planning process between the retailer and supplier. This involves a three step process in which proposals are made 12 weeks out, signed-off 10 weeks out and then implemented by the supply chain 8 weeks out. This involves the two companies reaching agreement on the scale of the forecast uplift in sales looking, for example, at the impact of previous promotions. Although this planning process has been in place for several years, there are reasons why predicting the demand of this product on promotion is difficult: the planning process is not always adhered to for commercial and trading reasons; the experience from past promotions is used to inform the current promotion but may not be a good guide; the form of the promotion and the current trading conditions will impact on the sales uplift achieved and thereby on the success of the promotion.

- Forecasting – The retailer runs a continuous replenishment system in which their ordering is related directly to till sales. Forecasting is relatively accurate but can be affected by weather patterns, particularly, daylight, temperature, humidity and sunshine. Weather forecasting is notoriously inaccurate but because of the long shelf life of the products in question, inaccuracies do not lead to waste. The supplier conducts extensive analysis of sales trends and has visibility of the retailer's sales data.
- Inventory management – 'Human error' for example not counting stock, mis-placing stock or putting the wrong numbers on the system can also cause problems. When product is moved from back of store to shelf there can be a temptation to place new stock at the front of or on top of existing products. If shoppers take these products from the fridges first then poor rotation of product in this way could lead to waste.
- Storage and in store display – Typically the retailer employs low skilled people and often students for this type of operation but reports that staff turnover is low. The retailer has clear processes in place for shelf management, but these are not always followed.
- Shelf life – The supplier aims to provide the retailer with 60-70% of the product's shelf life. This helps ensure the product is always available to meet consumer demand and in this way helps reduce waste. In general, the longer the shelf life available to the retailer the less waste there is. Both the retailer and supplier agree that waste would be reduced further if lead times could be shortened. Because of the long shelf life for this product very little waste arises from product beyond its 'sell by date'.
- Product recalls – Recalls are rare for these products but catastrophic when they happen.
- Intermediate and product packaging – All intermediate packaging for this product is recycled. Product packaging is designed to protect it from harm. Neither the retailer nor the supplier believed that improvements could be made in this case.

Destination of Waste – All waste for these products goes to landfill. When waste occurs both the product and its packaging are discarded. The retailer has a trial with Fareshare (but this does not involve these products).

5.1.3.1. Frozen luxury ice cream (F2)

Causes of Waste – This product has a low level of waste which is a function of the long shelf life. Demand variations arise for seasonal reasons, which are relatively predictable, and because of product promotions. The most prevalent cause of waste is inaccurate promotional forecasts. The uplift in sales achieved when the product goes on promotion cannot be predicted with accuracy.

- Equipment failure – Failures in refrigeration equipment at depots, in lorries or stores can lead to waste. These failures are more common in-store but

even there, they are infrequent events. Nevertheless, when they happen, a substantial amount of waste is generated.

5.1.3.2. Chilled Margarine spread (C4)

This product has a low level of waste which is a function of the long shelf life and stable demand. The most prevalent cause of waste is inaccurate promotional forecasts, as discussed above. If the promotion results in a smaller uplift in sales than envisaged it does not follow that product waste increases as promotion plans usually provide for the product to be sold through other channels. There are other causes of waste for this product but all are relatively minor.

5.1.3.3. Ambient pasta sauce (A4)

This product has a low level of waste which is a function of the long shelf life and relatively stable demand. Demand variations arise for seasonal reasons which are relatively predictable and because of product promotions. The most prevalent causes of waste for this product are:

- Promotional forecasting – As discussed in the general section for this set of cases, inaccurate promotional forecasting can cause waste although volumes of waste are low due to the long shelf life of the product.
- Packaging and product handling – The fragility of the packaging for this product can cause breakages if not appropriately handled. Typically the retailer employs low skilled people and often students for handling product and there is a risk of handling procedures not being followed.
- Intermediate and product packaging – All intermediate packaging for this product is recycled. Product packaging is designed to protect it from harm. Because this product is housed in glass there are breakages which lead to waste. However, breakage is not a significant cause of waste.

5.1.4. Non-grocery Retailer case study – Pre-packed sandwiches (C5)

This case study involved a retailer that does not specialise in food and groceries, but offers pre-packed sandwiches which are an important product category in terms of waste.

	Chilled Pre-packed sandwiches
Shelf life	2 days
Orders	Day 1 for delivery to store on day 3
Demand	Irregular but within bounds
Stock	Depot and distribution centre are stockless, stores carry minimum
Waste in-Store	7% (value of £7m a year)

The category director is responsible for waste, and store managers have waste targets, but these are not punitive. The product is sold in 730 of the retailer's stores in the UK. The top 230 stores account for 70% of sandwich sales and in volume terms generate most waste. Some stores have a low throughput of sandwiches and generate a high percentage of waste but only account for a low volume/value. Sandwiches account for about 75% of all waste for this retailer. The main issues related to waste are:

- Forecasting – Demand varies by about 20% from a low to a high point across the year. Within this range there are daily, weekly and monthly variations. Demand is highly impacted by weather variations, particularly in summer, and the retailer has dedicated individuals that manually adjust forecasts for different shop types (for example some are located in shopping malls and will be less affected by weather events).
- Ordering – The retailer uses a bespoke ordering system that has been adapted from the approach used for its main ambient lines. It is based on a moving average of historic sales but, unlike ambient, it is assumed that stores have no stocks. The category team can manually override the order to reflect weather events and feedback from store managers. Orders by depot are placed on a 3PL provider by 2200 hours on day 1 using store EPoS data correct at 1800 hours. The 3PL transfers the orders to the two sandwich suppliers by 2400 hours who deliver product to depot initially by 1000 hours on day 2. The 3PL picks sandwiches in the depots by store (completed by 1600) and takes them to the retailer's distribution centres where they are cross docked for delivery to store (with other store orders) on day 3.
- Promotion – To drive the lunchtime footfall, the retailer has run a longstanding 'meal deal' promotion. This promotion is now part of 'business as usual' and does not drive spikes in demand. The retailer has a loyalty card that entitles customers to obtain 1 free 'meal deal' per calendar month if that customer has purchased at least 5 during the period. This drives demand increases at the month end but does not cause waste.
- Shelf life – Sandwiches have a 2-day shelf life. As a result the retailer cannot respond to significant swings in demand by flexing stock at stores.
- Transport – All sandwiches (apart from central London) are delivered in thermal containers which are regularly probed. The delivery frequency increases in summer. In central London the retailer owns a fleet of vehicles that are used to replenish stores overnight. The vehicles have cooling systems and do not make use of the thermal containers.
- Storage and in-store display – Chiller units can sometimes cause problems depending variously on the weather, their location in-store and other factors. Occasional breakdowns particularly in summer result in significant waste and cause problems with ordering and forecasting. Store managers prefer to see full shelves. There can be tensions between stores and the central category team over ordering and merchandising.

- Product Packaging – The retailer has recently changed the product packaging from plastic to cardboard to aid recycling (all cardboard is compostable). Despite the cardboard being potentially less durable, there has been no significant increase in waste as a result.

A number of stores have local arrangements with charities to collect unsold sandwiches. However, because of potential litigation it is not a favoured option for dealing with waste. The main bulk of waste from this product goes into store waste and is disposed to landfill. The retailer is examining waste streams running a project to assess the impact of centralising store waste to depots but there are regulatory issues (for example controls on animal by-products) and as yet there are no definitive results.

5.1.5. Poultry producer - cases C6 and C7

The following two products were taken from a large producer of cooked, uncooked and frozen poultry. The selected products were both chilled meat. The first was sliced organic meat and the second was wafer thin style meat. As the products were similar in terms of production and manufacturing methods they shared the same main causes of waste. For this reason, the qualitative data for these two cases has been merged, but the quantitative data remains separate as presented in the following table.

	Cooked sliced organic meat	**Chilled wafer thin cooked meat**
Shelf life	10 days from pack, 6 days to consumer	26 days from pack, 15 days to consumer
Orders	Approximately 24hrs	Approximately 24 hours
Demand	Low Volume Product	60% of demand is promotion
Stock	1.5 days	2.5 Days
Waste in store	N/A	N/A
Total production volumes	411 tonnes	4600 Tonnes
Waste levels	Overall 1.85% wastage levels.	Overall 0.38% wastage levels
Waste volumes	7.6 tonnes pa	17.6 tonnes pa

Orders are received daily from retailers. Orders before 1400 hours will be delivered that evening. Service levels are 99.8%. Production system is make to stock but can move to make to order for some products due to more capacity in packaging. Inventory levels:

- Chilled 2-3 days
- Frozen 4-6 weeks
- Christmas frozen 26 weeks

The biggest cause of waste is a combination poor forecast accuracy and short shelf life (Depot = 12-15 days); the worst products are those with low volume and short shelf life. The main issues relating to waste for this organisation include:

- Forecasting – Forecasting of promotions takes place up to 26 weeks in advance and retailers confirm 2-3 weeks out. Collaborative forecasting can work, particularly for seasonal products (e.g. Christmas) which involves close relationships with daily communications. This collaboration produces accurate forecasts but consumes a lot of resources. Weather can also be a factor, particularly for cooked meats.
- Promotions – An additional complication is the use of promotions which for some products can account for more than 50% of volume. Base demand is usually fairly consistent but promotions introduce variability. Promotions planning with retailers can be problematic and lead to waste. Sometimes promotions are overestimated to increase the apparent financial return of the promotion and hence have them approved. As a result there is a degree of double guessing of promotional forecasts.
- Shelf life – This varies substantially between products: fresh 6 days, cooked 10-20 days, cured 26 days, frozen (crumb) 15-18 months; frozen (whole) 4 years. Retailers usually require 75% of shelf life.
- Packaging Changes – Changes in packaging / re-branding (e.g. labels and bags) can have a substantial impact on waste (write-offs) if the changes are not planned properly. The reason for this is that packaging stocks can be very high since they are ordered in large batches. Price changes on price marked packages can also have an impact (e.g. frozen Christmas products or sliced turkey/ham). This happens for marketing reasons but sometimes the effects and costs are not considered.
- Product Recalls – Recalls are rare events but can have a high impact, particularly on frozen products where stocks tend to be higher. This would generate waste but the company uses insurance so the cost implications are less severe.
- Failure of refrigeration equipment – These are also relatively rare events but can have a strong impact. Similarly, the company is insured against them.

Food that has exceeded the shelf life tolerance set by mainstream retailers goes to discounters and staff while it still has some shelf life left. Another alternative route is pet food producers. Packaging (plastic and cardboard) is recycled. The company's own staff strip out product that will go to waste, separating packaging and food. General waste (i.e. non recyclable plastic, and mixed waste) goes to landfill.

5.1.6. Chilled fruit drinks producer – Case study C8

This case study was with a premium food and drinks manufacturer and was based on their chilled fruit and vegetable juice based product range.

The company has been involved in a number of initiatives to eliminate factors contributing to waste. For instance, in order to increase shelf life, they developed new technologies such as advanced pasteurisation of products. Additionally, they have invested in developing a more robust forecasting model which can allow them to reduce safety stocks (currently they hold 8-10 days' stock) and hence reduce waste. For the future, it is planned that product at the end of its life is given away as promotion of product. A number of different organisations are helping them to measure and control waste, for example WRAP.

	Chilled Fruit Drinks
Shelf life	Long life goods: 40 days, short shelf life goods 20-25 days dependent on cool chain, store shelf life is ~30% of shelf life i.e. 21 days.
Orders	Day 1 for delivery to store on day 3
Demand	Demand variability is relatively high
Stock	8-10 days stock cover.
Waste in-store	3% in store and > 1% in manufacture
Responsibility	There is no dedicated member responsible for waste in the organisation. Supply Chain - KPI manager and Business Delivery Team manager are dealing with waste management in the organisation.

The main cause of waste for this product is a combination of forecasting error and the short shelf life of the product.

- Forecasting – Forecasts are made in collaboration with customers. Especially during promotion periods. Waste is directly correlated with forecasting error.
- Promotions – Promotions increase forecasting error and introduce other effects such as cannibalisation.
- Shelf life – A percentage of shelf life is spent at the manufacturer for safety stock. Safety stock level policies allow flexibility and might be helpful in keeping waste low.
- Packaging Changes – Using technology as a tool to extend shelf life and reduce waste such as oxygen scavenging cap. Impact on waste of a catastrophic failure on equipment depends on where the fault occurs due to the company's manufacturing process. Low waste from storage of products in packaging as sold in cardboard boxes and cartons.
- Balance of power – In general there is good collaboration with retailers and sales information is shared. However, due to imbalance of power there exists a pressure from big retailers on small manufacturers which can lead to waste.
- Seasonality and weather – perhaps surprisingly, weather and seasonality were reported as not significant for waste generation.

Waste of damaged products is land filled. The amount of packaging waste is very low and is recycled. Products that exceed the proportion of shelf life demanded by retailers but are still safe to consume are sent to charity, schools, prisons and hospitals (advertising on packaging for money generation) or are being sold to smaller retailers to reduce waste to lowest level possible.

5.1.7. Milk supplier – Case C9

This case was conducted with a milk supplier and focused on the supermarket's own brand milk. Milk is a natural product whose supply varies according to seasonal and dairy farm management practices. Milk is collected from the farm, processed and distributed to customers within 2 days. The supplier operates a strict date coding regime to ensure customers have the maximum available shelf life. Waste milk arises when the supplier's deliveries are rejected by the customer. Approximately 5,000 litres of milk a day is impacted in this way (less than 0.02% of production). If the milk has remained in the cool chain it can be re-processed (including pasteurisation) with 'virgin' milk for certain customers. Some milk cannot be re-used and becomes 'waste'. The main reasons why milk is rejected include:

- Poor stock rotation policies by customers with the result that milk with shorter shelf life is left at back of store and cannot be sold because consumers take milk with the longest remaining sell by or use by dates
- Supply quantities that do not match order quantities or have the wrong sell by or use by dates
- Planning errors caused by 'impulse orders' or 'over ordering'

Milk is promoted generically by industry-wide campaigns and by the supplier in relation to specific brands. Generic campaigns are primarily awareness raising and do not have a major impact on the yearly demand profile. Brand promotion diverts purchases from own brand milk but does not lead to waste because volumes are managed by the supplier.

	Milk supplier
Shelf life	12 days
Orders	Daily replenishment (2bn litres nationally per year)
Demand	Regular with summer dip and Xmas spike
Stock	0.5 days maximum (effectively stockless given throughput time of 24 hours with the supplier)
Waste in Store	Low

The company defines waste as product for which they have no further use for and has to be disposed of into alternative markets. Since milk cannot be sent to landfill, wasted milk is disposed of into animal feed, bio-gas and composting end uses. No packaging waste from milk goes to landfill, but they have a policy of zero

waste to landfill by 2010. Around 5-7 tonnes of HDPE bottles a week is 'waste' all of which is collected and re-processed.

- Packaging – The majority of own brand milk is supplied in HDPE bottles. Some cartons are used for small quantities for certain customers. Between 5-7 tonnes of HDPE a week is 'waste' relating to the milk that is returned by customers. All 'waste' HDPE bottles are collected and re-processed. No packaging waste goes to landfill. Tertiary packaging (cages, dollies) have a 10 year life with an average round trip of 4-5 days. The packaging (metal) is then re-cycled. Secondary packaging (shrink wrap, tie bands) has been eliminated except for deliveries to smaller retailers who require reduced quantities for ease of handling. Primary packaging is primarily HDPE bottles that can be re-cycled by both the supplier and by households.

The following items are incidentals to the production process and include packaging that cannot economically be re-cycled:

- Tetra-pack cartons
- Hairnets (a requirement for production staff)
- Certain types of plastics used in the suppliers' canteens
- Food waste from the suppliers' canteens
- Water cooler cups (made from PVC)

According to the interviewee the industry has an effective system for dealing with waste and in his view the main problem relates to household waste.

5.1.8. Supplier of chilled red meat – Case C10

This case involved a large meat supplier for food retailers. The focus here was on red meat and compares with case C3 where the retailer was vertically integrated with its suppliers.

This case revealed that there is great variability in the amount of waste, for example the proportion of waste for cooked meats is less than fresh meat and large retailers tend to have less waste than smaller ones. The key to reducing waste is to maintain a balance between on-shelf availability and waste.

Partnership with retailers, as opposed to a traditional tendering process, has proved to reduce waste (for example in relation to projects that focus on packaging reductions).

	Chilled red meat supplier
Shelf life	8-9 days
Orders	Day 1 for delivery to store day 2
Demand	Variable seasonal and daily

Stock	1.5 days
Waste in Store	6–10% main retailers, 15–30% convenience retailers
Responsibility	Waste is managed by site directors. The supplier's operations are decentralised. The business has no KPIs on waste (other than those relating to Government requirements on packaging).

The main issues related to waste for this product include:

- Promotional Planning – Some promotions are agreed in advance and others are not, which causes waste. Linked deals (2 for x) drive volume and are more consistent for manufacturers than BOGOF or half-price promotions which are inherently more unpredictable.
- Forecasting – Inherent volatility of sales driven by weather (e.g. BBQ season), seasonal events (e.g. Christmas) and promotional activity. The company relies on its own forecasts (some customers do not provide forecasts), but weather forecasting is difficult and bad weather in 2007 increased waste to 40% during a short period. Some retailers have good practice and provide weekly forecasts in advance and adjust them as the order date gets closer; others will give daily amends which cause more supplier waste (but less retail). Regular meetings are held with one customer that brings together the supplier's account manager, the customer's buyer and supply chain teams. Some retailers give discretion to store managers on the amount of space allocated for meat, and ordering does not necessarily reflect demand leading to 'out of stock' or wasted product. Three deliveries per week (not daily) are more typical in smaller stores so ordering is based on expectations and has higher variability.
- Storage and in store display – All retailers treat product differently. Some retailers have better handling, ergonomics, lighting and space management. Convenience retailers are not as effective, for example chilled product can stand around waiting because of limited back of store space. Temperature abuse will cause waste. Refrigeration failures are rare as large retailers have back ups. Customers with older stores, however, can have more problems. This can affect available shelf life and stock rotation in store, i.e. not pulling older stock forward in displays or 'hidden' pallets in DC (especially at Christmas).
- Shelf Life – Lead times have been reducing and the closer the order is in time to actual sales, the more accurate it is likely to be. This helps retailers manage their waste but it does not solve the problem through the supply chain. Shelf life for meat products can be extended for example: pork matures in 2-3 days and has a potential shelf life of 15-16 days. Beef matures in 14 days and has a potential shelf life of 28 days. Lamb matures in 1 day and has a potential shelf life of 21 days. New Zealand lamb, for instance spends 4-6 weeks on water and still has 2-3 weeks' shelf life in UK.

- Quality checks – All depots have Quality Control checks and retail technical managers will also check suppliers. These checks can identify problems such as occasional damage, for example pallets falling over.

5.1.9. Ambient oils and sauces – Case (A5)

This case study was with an oil and sauce manufacturer and compared two sales streams of a direct sale to a large supermarket, and a sale of materials to a food manufacturer.

	Ambient Oils and Sauces
Shelf life	12-18 months
Orders	Supermarket: 7 day delivery (usually 5) Food manufacturer: 5-7 day delivery (usually 3-4)
Demand	Some products have seasonality, evidence of consumers trading down. Weather also has an impact.
Stock	2.5-3 weeks
Waste in Store	5–10% in store
Responsibility	Waste manager in one plant, Ops/Manufacturing in other 2 plants

This product appears to have some significant levels of waste, particularly for the type of product which has a relatively long shelf life. The main issues contributing to waste are:

- Forecasting – Better forecasting would help to reduce waste. Some retailers do not even provide a forecast and when they are provided there is often a degree of second-guessing. The impact of weather changes on demand can be massive and seasonality can also have an impact.
- Promotional Planning – Promotions can introduce a degree of variability but they are not always a big factor.
- Storage and In Store Display – Temperature control on a limited range of products (16 +/- 1ºC); Distribution on chilled wagons; Limited impact on waste.
- Shelf Life – Retailers demand 75% of the product life but they can sell product at a discount if it is near the 75% threshold. For own brand products it is not possible to repackage and product is wasted. More flexibility in deliveries by retailers would help to reduce waste.
- Information flow – The company subscribes to receive POS information from retailers, but they have to pay for this data. POS data makes a difference, but information could be used more effectively to reduce waste.
- Packaging – The quality of packaging operations is as important as the design.
- Product damage – There is some broken glass, but this is not a major issue.

- Penalties for OTIF and recalls – There are penalties by retailers but penalties from food service companies are even higher. These penalties can help to focus the mind to try and reduce forecast error.

Damaged product can sometimes be reworked, otherwise it is destroyed or goes to landfill. Product with limited shelf life remaining can be sold to discounters at lower markings. Packaging is recycled or goes to landfill.

5.1.10. Ambient canned and bottled drinks – case study (A6)

This interview was conducted with a large drink supplier whose product range was essentially long shelf life soft drinks.

	Ambient canned and Bottled Drinks
Shelf life	75 days – 24 months
Orders	From 24 hrs (for major retailers using VMI system) to Day 1 for day 4 (for small retailers)
Demand	Some seasonality (holiday period), marketing initiatives (world cup) and weather
Stock	11 days
Waste in Store	Very low levels of product waste, most packaging recycled Finished product waste: 0.0001%
Responsibility	CSR Perspective: Environmental General Manager Tactical: General Manager - Quality Environment, Safety & Health Implementation: Plant managers - Quality Environment, Safety & Health

It was found that product waste is minimal because product can be discounted to some retailers if it has less than 75% of shelf life but more than 12 weeks left. It is estimated that about 0.0001% of finished product goes to waste). Given that waste of product is minimal, there are no substantial causes of waste. However, we have decided to provide an examination of a number of issues discussed with the company in relation to waste.

- Forecasting – Forecasting practices have very little impact. Product is sold at a discount but is not wasted. Vendor managed inventory with many major retailers, the top 15% of customers account for 85% of sales. No problems with lead times. Weather creates volatility but does not affect waste. Product can have seasonality but does not affect waste.
- Promotions – Only an impact for very specific promotions. Promotions are common but generally well planned.
- Shelf life – No real problems with shelf life policies on waste.
- Inventory management and storage – Limited impact of stacking and shelving policies. 'Retail ready' packaging reduces packaging waste along the chain.

Changing practices by retailers can affect logistics efficiency (i.e. vehicle utilisation.) 'Project Rubik', trying to maximise cube of vehicles.

- Packaging Changes – Rare cases of glass breaking. Packaging design can have a big impact on waste. Sometimes marketing designs are not practical from a production/logistics perspective. Some products are more difficult to logistically manage than others. Hence some need for more packaging. Sometimes product redesign might be required. Sometimes pallets have to be restacked but do not generate waste.
- Product recalls – Rare (one every 3-4 years). Waste can be high but recycled where appropriate or pay for disposal. Sometimes product can be reworked.
- Equipment failure – Not a problem as all product is ambient. In the future might be a problem as expected to enter chilled market.

Most waste, mainly packaging but also damaged product is recycled. Around 4.5% (192 T) of all waste goes to landfill, the remaining 95.5% is recycled or reused.

5.1.11. Multiple suppliers - retailer: Fruits and vegetables – Cases C2, A2, A7

The following data was taken from a group session in a retailer/supplier workshop involving a large retailer and a fresh fruit and vegetable supplier. The three chosen products were bagged salad, raspberries and peppers.

5.1.11.1. Bagged salad chilled (C2)

This product has a high quality specification and can therefore lead to waste from rejected deliveries or on-shelf in-store rejection. Due to the retailer's high service level, occasionally there can be an over-stock of product to meet customer expectations of availability. Other factors include design changes in packaging causing packaging waste and the unpredictability of demand due to the weather.

- Promotional Planning – Promotions can lead to victim waste in store as promoted salad outsells other products. The tail off of a promotion can also lead to in-store waste as well as an underachieving promotion causing waste within the pipeline.
- Forecasting – Very inaccurate and dependent on the weather. Impossible to forecast long term and usually ends up with over production to meet customer expectations of availability.
- Seasonality – Demand is less predictable in summer time due to volume. Winter months rely on imports which can reduce the in-store shelf life of the product due to length of time in transit (5 days from order placement).

Destination of Waste – As this is a short shelf life, delicate and bagged/branded product there is no alternative outlet for waste so it is land filled.

5.1.11.2. Raspberries (A2)

This product has a short shelf life and is expected to be of high quality so waste tends to be high to very high. Grading of fruit and defective fruit can increase amount of waste in the supply chain. This waste can be reduced by training pickers to select better fruit. The weather has a large effect on demand and it can be difficult to predict in the long term which can lead to storage issues.

- Promotional Planning – Promotions are seen as a good tool for managing waste. Seasonal fluctuations can be overcome by running a promotion to increase sales and clear fruit near limit of shelf life.
- Storage and In store Display – If not stored correctly can affect product quality. Poor store handling can lead to more waste. Problems with packaging changes and suppliers have problems with different packaging used by different retailers.
- Forecasting – Expected depot rejections account for large amount of waste of this product. Forecasting is modelled against volume grown against volume sold which is dramatically affected by weather.
- Seasonality – Demand is less predictable in summer time due to volume. Winter months rely on imports which can reduce the in-store shelf life of the product due to length of time in transit (5 days from order placement).

Destination of Waste – As this is a short shelf life and delicate product there is often no alternative outlet for waste so it is land filled.

5.1.11.3. Peppers (A7)

From the discussion the main causes of waste again stem from depot rejection of low quality produce. Cool chain abuse was also cited as a concern for this product as well as poor product handling from distribution centre to store. Also mentioned were the effects of in-store abuse of this product from customer handling.

- Promotional Planning – promotions of this product are rare and generally waste that arises from these promotions are due to poor product placement on the shelf (i.e. not in sight of customer).
- Forecasting – forecasting accuracy is down to store management and computer programs such as Crystal Ball. Trading conditions such as weather and supply can reduce the accuracy of forecasts.
- Seasonality – demand management is in place to reduce gaps in supply chain and inconsistencies of stock levels. Waste occurs when weather is poor and there is over availability of the product.

Destination of Waste – As this is a short shelf life and delicate product there is often no alternative outlet for waste so it is land filled.

5.1.12. Citrus Fruits – Case A8

This case involved a large producer and importer of fresh fruit and vegetables based in the UK. This case study specifically focussed on citrus fruit, including oranges, lemons and grapefruits etc. This product has a northern hemisphere and southern hemisphere production process which changes with the seasons.

	Citrus Fruits
Shelf life	Can be up to 10 days + depending on retailer's cold chain
Orders	Same day, orders are processed in the morning and delivered that night
Demand	Stable with a 3 fold increase over Christmas period. Some loss to soft fruit over summer.
Stock	10 days southern hemisphere, 2-3 days northern hemisphere
Waste in Store	Waste is at a moderate constant level of 5%
Responsibility	Partnered with other producer for waste management.

The total production of the plant was 18-20,000 pallets and 900,000 cartons to one of its partnered retailers per year. The producer also sends a further 3 million plus cartons to other retail partners.

Over the past 12 months the company produced over 500 tonnes of organic waste of which a proportion was from one of the partnered retailers who rejected some fruit for various reasons including poor visual quality, packing faults and date and price fault on the label stamps. Two production sites generated 272 tonnes of general waste of which 28% is land filled. Nearly 500 tonnes of cardboard waste is produced and around 7 tonnes of plastics waste is produced, which is mostly recycled.

From the discussion, the main cause of waste was mould on the products. This is caused by batch disease, incorrect temperature/humidity storage or handling and packaging errors.

- Promotional Planning – All promotions are agreed in advance to reduce waste. This company has good relationships and a strong foothold with the retailers. If more product is ordered in anticipation of a failed promotion then the company looks for other routes to market.
- Forecasting – can be an issue but not a major concern. Primarily based on previous year's sales data. The set-up involves a long term forecast, a weekly forecast and a pre-final order. The latter being the most useful.
- Seasonality – marginal with more impact on summer soft fruits.

Destination of Waste – There are alternative routes to market for product that is downgraded or damaged. There is also a waste stream used for composting. Packaging and other waste is mostly recycled with landfill as a last resort.

5.2. Cross-case analysis

To analyse the similarities and differences across cases, key bits of information were extracted from the individual case reports and put into tables for ease of comparison. Products were classified by temperature regimes: chilled, ambient and frozen and tables were created for each class. The salient points for each of the temperature regimes are presented below:

5.2.1. Chilled

Fifty percent of the case studies involved chilled products such as milk, sandwiches, meat and poultry (see tables XXI and XXII). The reason for placing more emphasis on this category was that chilled products tend to be more susceptible to waste due to their comparatively short shelf-lives. The range of shelf-life for the products selected was between 3 days (sandwiched) and 8 weeks (margarine).

As expected, some products in this category presented high levels of waste but this was not true for all cases. Figures ranged between 0.1% waste (e.g. milk) through to 30% (meat) in extreme cases. This high variability indicates that other factors in addition to temperature regime are affecting waste. The main causes of waste identified for this category were:

- Poor forecasting / unpredictable demand: the most common quoted cause of waste for this category was poor forecasting. However, upon further investigation it was found that in many cases it was not the inadequate use of forecasting techniques that caused a problem but the variability in demand. This distinction is important because whilst forecasting can be improved through training and use of software, variability is more difficult to control. Demand can vary for a variety of reasons such as weather, seasonality, national and regional events, many of which are uncontrollable and some variability (and forecast error) cannot be avoided.
- Weather and seasonality effects: weather effects and seasonality were the most common causes for variability in demand. For some products such as meats during the barbecue season, demand fluctuations due to weather can be extremely high. Combined with the short shelf-life of chilled products, these fluctuations can lead to waste at both retailers and producers. However, weather and seasonality do not affect all products in the same way, for instance milk has very stable demand throughout the year and this helps maintain low levels of waste despite its short shelf-life
- Poor promotions management: promotions are another factor that can affect unpredictability of demand. Extensive use of retail promotions affects demand not only for the products promoted, but also other product ranges due to cannibalisation. Although most organisations recognise that promotions can have many benefits, they also accepts that it also creates uncertainty which can lead to waste. However, promotions can also be used to reduce waste by discounting products when there is high supply (glut) or when they are reaching the end of their shelf-life.

- Poor stock rotation: Companies generally have clear stock rotation procedures to prevent waste, however this are not always followed due to insufficient training or because of high pressure during busy times such as Christmas. Not following stock rotation procedures will lead to products being left in depots, backrooms and shelves, causing waste as a result.
- Product damage: Product can get damaged at different stages in the chain and this can be due to packaging or handling issues. Fresh fruits and vegetables are particularly susceptible to this problem. This cause is not specific to chilled products.
- Rejections at delivery: Some products, particularly fruits and vegetables, can be rejected at point of delivery due to appearance and other quality related issues. In these cases, due to the short shelf-life of this products, it can difficult to find another customer for the products and they have to be wasted.
- Packaging changes: Changes to packaging and labelling due to marketing reasons are a cause of packing waste, because packaging is usually bought in large quantities, well in advance of production. This is a common cause for all three categories of product.
- Cold chain maintenance and failure in refrigeration: Failure in refrigeration equipment is rare but potentially disastrous situation in terms of waste. In this cases companies then to be more concerned about the commercial loss and the impact on availability. Furthermore, companies are usually insured against this type of loss.
- Recalls: product recalls or withdrawals are relatively rare events but with high potential impact, particularly if the product needs to be destroyed. Similarly to failures in refrigeration, companies are very concerned about this type of issue, not only because of the waste it generates, but because on their impact on availability and possible impact on reputation.

Table XXI: Chilled products case studies

	C1	C2	C3	C4	C5
Product category	Milk	Vegetables (bagged salad)	Red meat	Margarine	Sandwiches (pre-packed)
Temperature regime	Chilled	Chilled	Chilled	Chilled	Chilled
Focus	Retail	Supplier – Retail	Retail – producer	Retailer – supplier	Retailer
Shelf life	3 days (average in retail)	3 days	7 days	8 weeks	2 days
Lead-time	Day 1 for day 3	Variable (seasonality)	Day 1 for day 2 in store	D1 for D3 in RDC, D4 in store	Day 1 for day 3 (store)
Demand variability	Stable / predictable	Seasonal (summer uplift)	Irregular	Stable	Irregular (seasonal and weather a)
Stock	1.5 days at depot 1.5 days at store		1 day	7 days in store - stockless depot 3 days at supplier	1 day
Waste	0.1 % (Very Low)	High – Very high	Low	Low	7% (Very high)
Main causes of waste	- Damage (poor handling)	- Unpredictable demand - Inaccurate forecasting - Retailers service level requirements (over stock) - Promotions - Rejected deliveries (quality) - Packaging design changes - Seasonality of supply (longer transport in winter)	- Product out of shelf life	- Inaccurate promotional forecasts - Poor stock rotation (shelf) - Failure in refrigeration equipment (rare but high impact) - Recalls (rare but high impact)	- Irregular demand - Inflated orders to make shelves look full - Poor stock rotation (shelf) - Failure in refrigeration equipment
Good practices	- Clarity of responsibilities - Performance measurement - Forecasting and replenishment software - Orders place automatically by adjusted re-order point system - Sales visibility to all suppliers - Reducing waste to landfill		- Butcher in store helps to preserve the product for longer - Shorten lead times (vertical integration) - Visibility of promotions (vertical integration) - Availability sacrificed in promotions - Forecasting influenced by historic data, seasonal events and weather. - Ordering managed centrally but store managers can flex - Culture of waste reduction	- Product with short shelf life left sold through other channels - Clear responsibilities for waste management - Clear promotional planning process (not always followed) - Clear process for shelf management (not always followed) - Continuous replenishment related to till sales. - Product with short shelf life sold through other channels that mainstream retailers	- Forecasts are manually adjusted to account for regional variations - Promotions run constantly so don't affect waste - Change packaging from plastic to cardboard to increase recycling (although cardboard is less durable) - Clear responsibility for waste
Destination of waste	Landfill (aim to reduce to zero)	Landfill	- Landfill - Trials on anaerobic digestion	- Recycle secondary packaging - Landfill - Retailer has trial with Fareshare	- Local arrangements with charities to collect unsold product - Mainly goes to landfill

Table XXII: Chilled products case studies (continued)

	C6	C7	C8	C9	C10
Product category	Cooked poultry (organic)	Cooked poultry	Fruit drinks	Milk (own brand)	Fresh meat
Temperature regime	Chilled	Chilled	Chilled	Chilled	Chilled
Focus	Producer	Producer	Producer	Producer (single retailer)	Producer
Shelf life	10 days	26 days	20-40 days	12 days	8-9 days
Lead-time	Same day for orders before 2.00; else day 1 for day 2	Same day for orders before 2.00; else day 1 for day 2	12 to 36 hrs	2 days from farm to depot 2 days to store	Day 1 for delivery to store on day 2
Demand variability	Irregular (low volume; weather)	Irregular (Promotion; weather)	High	Stable (some seasonality)	Variable (seasonal and weather)
Stock	1.5 days	2.5 days	8-10 days	0.5 days	1.5 days
Waste	1.85 % (producer) Very low	0.38% (producer) Very low	3% in store; 1% in manufacture Intermediate	0.02% Very low	6-10% main retailers; 15-30% in convenience (High – Very High)
Main causes of waste	- Combination of poor forecast accuracy and short shelf life - Low volume - Packaging changes and price changes can cause waste	- Combination of poor forecast accuracy and short shelf life - Promotions planning with retailers (base demand is stable but promotions cause variability) - Packaging changes and price changes can cause waste	- Forecasting error - Promotional forecasting - Cannibalisation during promotions - Product damage	- Rejected deliveries - Poor stock rotation - Wrong date coding - Planning errors - Cannibalization (brand promotions slow down demand, but not major impact)	- Bad weather - Achieving a balance between OSA and waste - Differences in appearance (customer pick) - Volatility in small retailers - Occasional damage
Good practices	- Collaborative forecasting delivers more accurate forecast but is resource intensive (particularly for seasonal products) - Use of alternative routes to market, such as discounters and pet food producers for product with short remaining shelf life	- Collaborative forecasting delivers more accurate forecast but is resource intensive (particularly for seasonal products) - Use of alternative routes to market, such as discounters and pet food producers for product with short remaining shelf life	- Sharing of data and close collaboration with retailers - Pasteurisation technologies to increase product life. - Use of packaging to increase shelf life. - Developing new forecasting model to reduce forecast error.	- No waste to landfill - Effective system leading to very low levels of waste.	- Clear responsibilities for waste - Partnership with retailers - Regular meetings with retailers - Use of implants with large retailers to reduce forecast error - Some promotions create less unpredictability (e.g. link deals) - Some retailers treat product better (e.g. handling, ergonomics, lighting, stock , temperature) - Looking at approaches to extend shelf life
Destination of waste	- Packaging waste is recycled - General waste goes to landfill. - Products can be stripped to separate waste.	- Packaging waste is recycled - General waste goes to landfill. - Products can be stripped to separate waste.	- Damaged product goes to landfill - Planning to give away product with short shelf life left.	- Animal feed, bio-gas and composting - Milk cannot be sent to landfill - Packaging is recycled - Durable tertiary packaging	

5.2.2. Ambient

The main issues affecting the case studies involving ambient products are summarised in tables XXIII and XXIV). These cases revealed variable levels of waste, but none of the cases exceeded 10% waste. The range of shelf-life for products in this category was very wide, ranging from 3 days to 24 months and invariably products with shorter shelf-lives tended to have higher levels of waste. In addition to shelf-life, the main causes of waste identified for this category are:

- Poor forecasting / unpredictable demand: similarly to chilled products, inaccuracies in forecasting caused by unpredictable demand are one of the dominant causes of waste. However, this problem tends to disproportionally affect products with short shelf-lives.
- Poor promotions management: promotions have similar effects on ambient products than on chilled products. They have a negative effect by creating demand uncertainty and they have a positive effect by helping to move product when supply is high.
- Product quality issues / rejections: rejections of product are prevalent in products with natural variability such as fruits and vegetables.
- Poor inventory management: Inventory management practices, particularly around stock rotation can cause product to exceed its shelf-life before it reaches the customer. In these cases the product will be wasted and generally go to landfill.
- Seasonality of demand/supply: seasonality of demand can be one of the causes for forecasting error, which can lead to waste.
- Weather effects: some ambient products are also affected by fluctuations in demand due to weather. This can generate waste, particularly for products with short shelf-lives.
- Product damage: similar to chilled products, ambient products can be damaged due to poor handling or due to natural product fragility, particularly in the case of fruits and vegetables.
- Storage conditions: although ambient products tend not to suffer much from storage conditions, the appearance and integrity of some products can be affected if storage conditions are extreme (too cold or too hot).
- Recalls: same as for chilled products.

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Table XXIII: Ambient product case studies

	A1	A2	A3	A4
Product category	Fruits and Vegetables (potatoes)	Fruits and Vegetables (raspberries)	Fruit and vegetables (general)	Pasta sauce
Temperature regime	Ambient	Ambient	Ambient	Ambient
Focus	Retail	Supplier – Retailer	Retail - producer	Retailer – supplier
Shelf life	3-5 days	3 day	Product dependent (short)	9 months
Lead-time	Day 1 for day 2 in RDC day 3 in store	N/A	Day 1 for day 2 in store	Day 1 for day 3 in RDC, day 4 in store
Demand variability	Seasonal (winter uplift)	Seasonal supply and demand (summer uplift)	Irregular	Stable Seasonal variations
Stock	1.5 days in depot 1.5 days in store	N/A	1 day in store (average)	7 days in store 4-7 days in dept 14-28 days at supplier
Waste	Low	High – Very High	Low	Low
Main causes of waste	- Inaccurate forecasting - Insufficient shelf space available - Exceptionally poor handling	- Quality expectations (reject) - Weather effects on demand - Difficult to predict demand - Poor store handling	- Product damage - Difficulties in predicting demand accurately	- Inaccurate promotional forecast - Damage - Product handling - Recalls (rare but high impact)
Good practices	- Efficient handling (reduce order – delivery time) - Clarity of responsibilities - Performance measurement - forecasting and replenishment software - Orders place automatically by adjusted re-order point system - Sales visibility to all suppliers	- Train packers to select appropriate fruit. - Promotions used to manage waste (cope with seasonal fluctuations) -	- Shorten lead times (trough vertical integration) - Visibility of promotions (vertical integration) - Availability sacrificed in promotions - Forecasting influenced by historical data, seasonal events and weather. - Ordering managed centrally but store managers can flex - Experimenting with packaging to protect products - Culture of waste reduction	- Product with short shelf life left sold through other channels - Clear responsibilities for waste management - Clear promotional planning process (not always followed) - Clear process for shelf management (not always followed) - Continuous replenishment related to till sales. - Product with short shelf life sold through other channels that mainstream retailers
Destination of waste	Landfill (aim to reduce to zero)	Landfill	- Recycling or landfill - Trials on anaerobic digestion	- Landfill - Retailer has trial with Fareshare

Table XXIV: Ambient product case studies (Continued)

	A5	A6	A7	A8
Product category	Oils	Drinks	Fruits and Vegetables (peppers)	Fruits and Vegetables (citrus)
Temperature regime	Ambient	Ambient	Ambient	Ambient
Focus	Producer	Producer	Supplier - Retailer	Supplier
Shelf life	12-18 months	75 days – 24 months	2 weeks	10 days (more dependent on cold chain)
Lead-time	3-4 days	From 1 to 3 days depending on customer	N/A	Same day
Demand variability	Stable (some seasonality and weather impacts)	Moderately stable (seasonality, marketing initiatives and weather)	Seasonal and weather dependent	Stable with 3 fold increase in Christmas
Stock	17 – 21 days	11 days	N/A	10 days southern hemisphere; 2 -3 days northern hemisphere
Waste	5-10%:-High – Very high	Very Low (most waste is packaging)	Intermediate	Around 5% Moderate - High
Main causes of waste	- Forecasting error; out of shelf life - Damage (broken glass) - Quality issues (rejects)	- Some promotions can cause waste - Product can get damaged but not very significant	- Depot rejections: low quality product - Damage: handling and in-store damage by customer - Waste occurs when weather is poor and there is over availability of the product.	- Product quality issues like mould and disease - Incorrect temperature / humidity storage - Packaging / labelling errors
Good practices	- Visibility of retailer information (POS) and forecast, but need to pay for POS data! - Storage and in store displays can impact waste - Product with short shelf life left can be sold to discounters, but not for own brand product. - The threat of penalties for not delivering OTIF motivates to reduce forecast error.	- Product with short life left is discounted - Seasonality and weather fluctuations don't affect waste due to long shelf life	- Use of forecasting software; use forecast from retailer - Demand management approach to reduce gaps in supply chain and inconsistencies in stock levels	- Promotions agreed with retailer help to reduce waste
Destination of waste	- Can be destroyed or reworked - Some returnable packaging	- Mainly recycle - 4.5% of all waste goes to landfill	- Landfill	28 % is land-filled Packaging is recycled

5.2.3. Frozen

Initially it was planned to conduct three case studies in the frozen category, however due to the very low levels of waste found in the first two cases it was decided to shift the efforts to chilled and ambient products. The highlights for both case studies are presented in Table XXV.

For both products analysed in this category (<1%). The main reason for this is that this kind of product tends to have very long self-lives, more than 6 months, so they are not affected by fluctuations in demand. The main causes of waste revealed for this product category are:

- Damage (packaging): Since product tends to be stored for longer periods of time, damage can occur along the chain.
- Inaccurate promotional forecast: inaccurate forecasting, particularly during promotions, could create very high inventories which might lead to waste.
- Human error (inventory): errors in inventory management can lead to product exceeding its shelf life, leading to waste.
- Cold chain maintenance: similar to chilled products, factors affecting the cold chain can have a big impact, which is potentially higher in the case of frozen products because inventory levels tend to be higher than in chilled..
- Recalls: same as for chilled and ambient products.

Table XXV: Frozen Product case studies

	F1	F2
Product category	Vegetables	Ice cream
Temperature regime	Frozen	Frozen
Focus	Retail	Retailer – supplier
Shelf life	6 months +	18 months
Lead-time	Day 1 for day 3	Day 1 for day 3 in RDC, day 4 in store
Demand variability	Stable with some seasonality	Highly seasonal / Weather dependent
Stock	7 days depot 7 days store	7 days in store Stockless depot
Waste	0.12% Very Low	Very low
Main causes of waste	- Damage (packaging) - Failure in refrigeration (rare but high impact)	- Inaccurate promotional forecast - Human error (inventory) - Failure in refrigeration equipment (rare but high impact) - Recalls (rare but high impact)
Good practices	- Clarity of responsibilities - Performance measurement - Forecasting and replenishment software - Orders place automatically by adjusted re-order point system - Sales visibility to all suppliers - Reducing waste to landfill	- Clear responsibilities for waste management - Clear promotional planning process (not always followed) - Clear process for shelf management (not always followed) - Continuous replenishment related to till sales. - Product with short shelf life left sold through other channels
Destination of waste	Landfill (aim to reduce to zero)	- Landfill - Retailer has trial with Fareshare

5.3. Causes of waste

A summary of all the products analysed in the case studies is presented in table VIII. The table indicates the main characteristics of each product, the level of waste and main causes of waste. Products are classified according to their level of waste, ranging from very-high (> 7%), high (5-7%), Medium (3-5%), Low (1-3%) and Very Low (< 1%).

Only one product, pre-packed red meat, was classified in the very high category and the main causes for waste include a variety of causes including short shelf-life, weather, availability and damage. Four products were categorised in the range between high - very high. These products tend to suffer from similar issues, such as forecasting, promotions, weather effects and damage. The products with high and medium levels of waste have a mix of chilled and ambient products, all of them with short shelf-lives. The products with low and very low levels of waste include a mix of products, several have medium to long shelf-lives, however others, such as milk and cooked poultry have short shelf lives and require chilling.

Table XXVI shows that although a variety of reasons are mentioned as main causes of waste, there are many commonalities across the different products, with reasons, such as short shelf-life, unpredictable demand, poor forecasting and weather effects appearing in many of the products. This appears to indicate that many of the root causes might be common across products.

Table XXVI: Main causes of waste

Products	Product Characteristics	Waste	Main Causes of Waste
Fresh red meat (pre-packed)	Chilled, Short shelf-life	V High	Bad weather, shelf-life, balance between availability and waste, differences in appearance, volatility in small retailers, occasional damage
Sandwiches	Chilled; very short shelf-life	High - V High	Planning and forecasting, variability of demand and shelf-life
Vegetables (bagged salads)	Chilled, very short shelf-life	High - V High	Unpredictable demand / forecasting, shelf-life, service level requirements, promotions, rejected deliveries (quality), packaging design changes, seasonality of supply (longer transport in winter)
Fresh fruit (raspberries)	Chilled + Ambient; short shelf-life	High - V high	Quality expectations (reject), weather effects on demand, demand predictability, handling
Oils	Ambient, long shelf-life	High - V high	Forecasting error, damage (broken glass), poor quality i
Fresh fruits (citrus)	Ambient, short shelf-life	High	Poor quality, incorrect storage, packaging and labelling issues
Fresh veg (peppers)	Ambient, short shelf-life	Med	Poor quality, handling and storage, weather fluctuations
Fruit drinks	Chilled; short-long shelf-life	Med	Forecasting, promotions (cannibalization) shelf-life, product damage
Fresh Veg. (general)	Ambient; short-medium shelf-life	Low	Product damage, difficulties in predicting demand accurately
Potatoes	Ambient; short shelf-life, seasonality	Low	Handling, shelf-life, inaccurate forecasting
Margarine	Chilled; medium shelf-life	Low	Temperature control, shelf-life, promotions, stock rotation
Cooked poultry	Chilled; short shelf-life; promotional, low volume	Low	Promotions planning, temperature control, shelf-life, demand variability
Cooked poultry (organic)	Chilled; short shelf-life, high value	V Low	Promotions planning, temperature control, shelf-life,
Milk	Chilled; short shelf live; low demand variability	V Low	Temperature abuse
Milk (own brand)	Chilled; short shelf live; low demand variability	V Low	Poor stock rotation, wrong date coding, planning errors, promo cannibalization
Beverages	Ambient; long shelf-life	V Low	Poor inventory management, promotions

Products	Product Characteristics	Waste	Main Causes of Waste
Past Sauce	Long life; fragile packaging	V. Low	Handling
Ice Cream	Frozen; long life, variable demand	V Low	Temperature control, handling
Frozen vegetable	Frozen; long shelf-life	V Low	Temperature control, handling
Fresh Veg. (general)	Ambient; short-medium shelf-life	Low	Product damage, difficulties in predicting demand accurately

Figure 14 presents a diagram comparing the waste ranges against the shelf-life of the products in the study. It is clear that the majority of products with high and very-high waste are products with short shelf-lives. Similarly the majority of products with long shelf-lives, such as ice cream, pasta sauces and beverages tend to have very low levels of waste. The only exception is the case of oils, which indicate a high level of waste despite their long shelf-life. This case study reveals other causes of waste, such as poor handling, poor inventory management and the effects of storage conditions on the appearance of the product.

It is important to note that not all products with short shelf-lives have high levels of waste, several products such as milk, cooked poultry and potatoes have low to very low levels of waste. These products however, have relatively stable demand patterns throughout the year, as they are not substantially affected by factors, like seasonality, weather and promotions. This is an important finding because it shows that the causes are not independent.

It is not surprising that shelf-life appears as a dominant cause of waste, as it determines the window in which the products can be sold to the customer. However, it is important to point out that management practices have a limited impact on the shelf-life of products. Packaging technologies and cold chains can help to extend the shelf-life of products, but the main factor affecting shelf-live is the nature of the products.

Figure 14: Waste vs. shelf-life

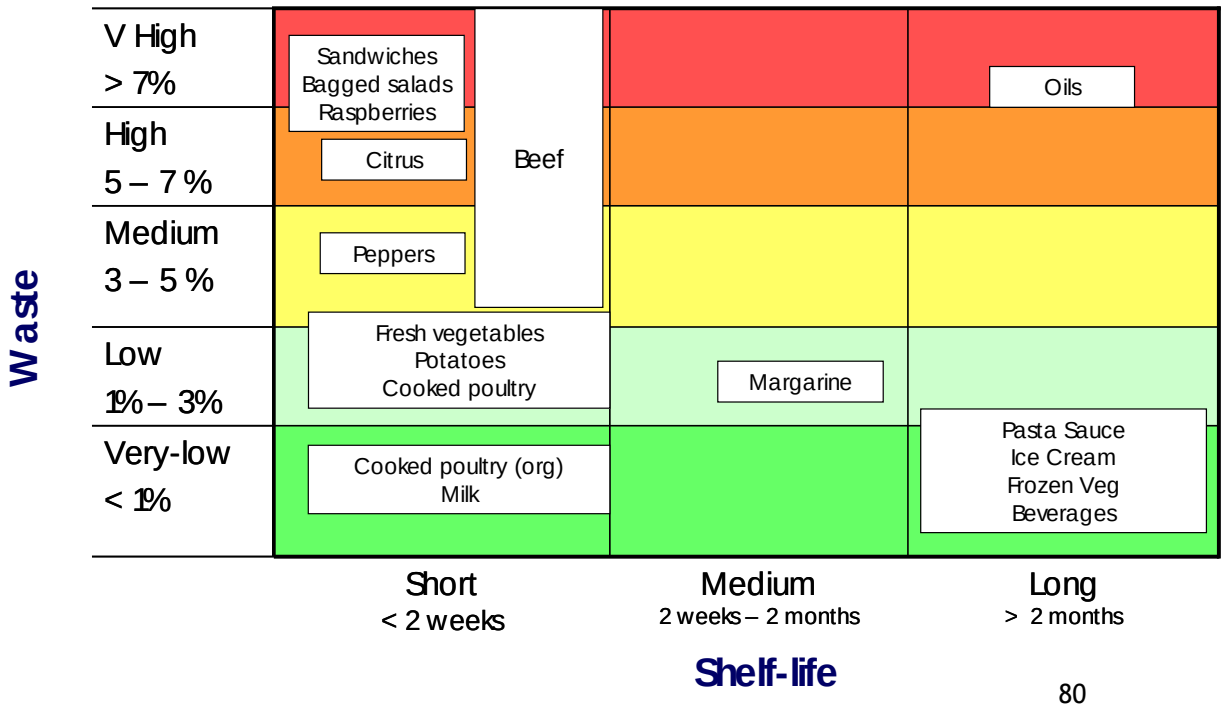
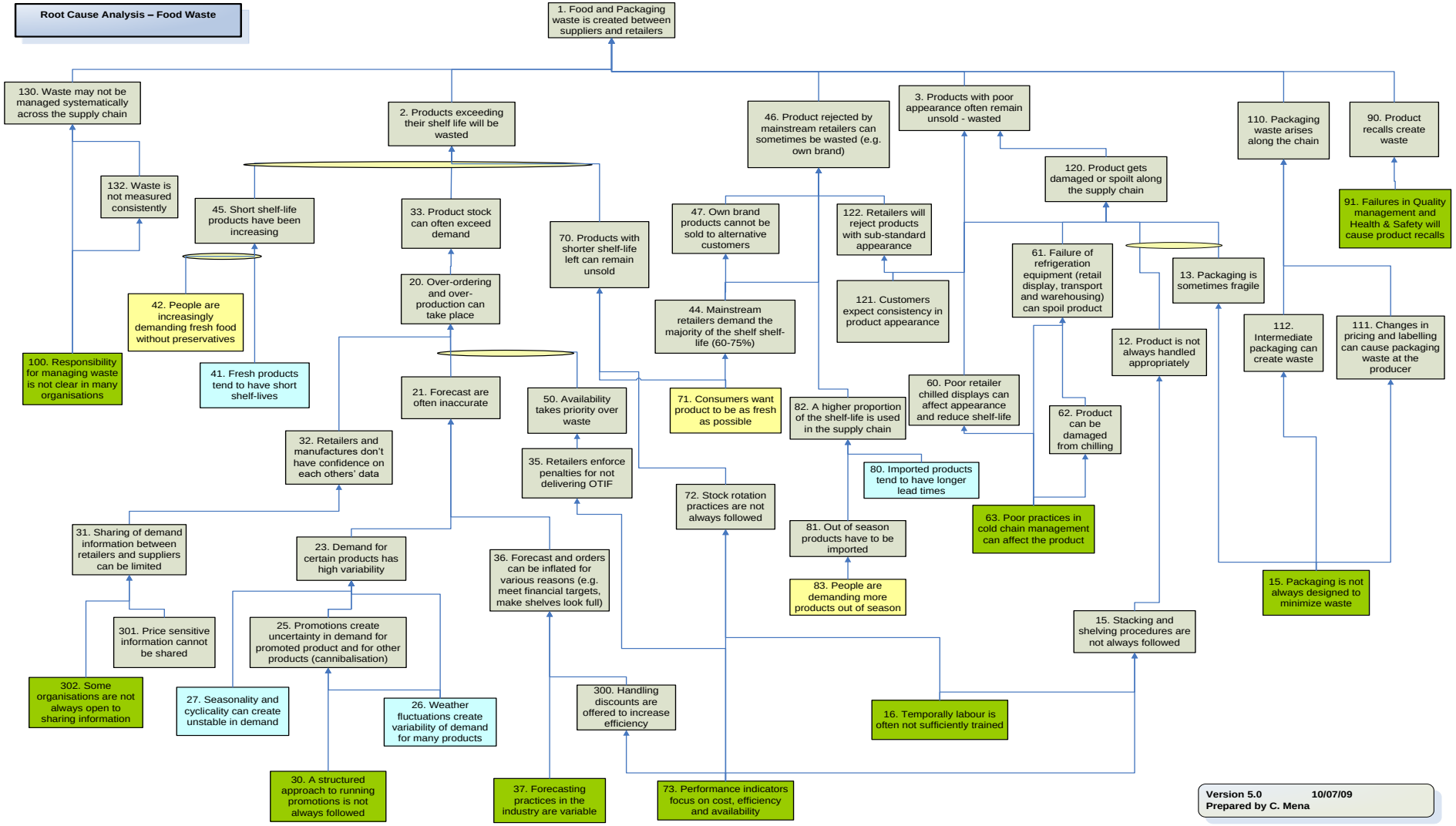


Figure 14 also shows a wide range of waste levels found for the two beef cases. This indicates that different practices in the management of the supply chain for different products can have a substantial impact on waste. In the case with the lower levels of waste, it was found that there was a high level of vertical integration in the chain and that the meat was butchered in the store. On the other hand, in the case with high levels of waste, it was found that large retailers were better at managing waste while small convenience stores had the highest levels of waste. These issues indicate management factors can also have a substantial impact.

5.3.1. Mapping the root-causes of waste

The initial analysis into the causes of waste revealed thee important issues: that many causes are common across products, that causes are interdependent and that some of the causes are not the result of management practices, such as short-shelf lives and weather fluctuations. These issues motivated us to perform further analysis which could help us understand the complexity of the problem and identify the root causes. For this reason, we decided to use a tool that maps the logic between causes and effects creating a tree where at the top you have the symptoms and at the bottom the root causes. Figure 15 presents the root causes map; at the top of the tree we find the creation of waste between retailers and suppliers and at the bottom we find the root causes of waste.

Figure 15: Root causes map



The root-cause map in figure 2 classifies root-causes of waste into three groups:

a) Mega-trends (yellow boxes): these are industry trends that affect the problem of waste, such as increasing demand for fresh products (71), and products out of season (83), as well as a move away from products with preservatives (42). These are important factors affecting the waste problem, but the impact that company strategies and processes have on them is limited.

b) Natural constraints (blue boxes): these are factors that influence waste, but that are associated with the nature of the products or process. Issues like short shelf-life of fresh products (41), seasonality of supply and demand (27), weather fluctuations (26) and longer lead-times for imported products (80) are among these factors.

c) Management root-causes (dark green boxes): these are factors affecting waste on which management practices have a direct impact. We believe these are the root-causes that are worth exploring in detail, since it is by changing these issues that organisations will be able to reduce waste. Each of these causes is discussed in more detail below:

   - **Waste management responsibilities (100):** While some companies have very clear roles and responsibilities for managing waste, others do not have a specific role with in the company focusing on waste. This usually means that waste is not measured and managed systematically and this situation is likely to lead to increased waste.

   - **Information sharing (302):** Accurate and timely information is essential for good planning and forecasting. When information is limited, variations between forecast and orders can increase and this could lead to waste. Furthermore, variations caused by poor information sharing can amplify across the supply chain. This amplification is a commonly known phenomenon known as the bullwhip effect (Lee, et al. 1997a,b)

     While some companies are effective at sharing information with their supply chain partners other are not. For instance, it was found that some retailers would charge for point of sale (POS) data, while others would give it away free. Poor practices in terms of information sharing can not only create waste but undermine the confidence in the information provided.

   - **Promotions Management (30):** Promotions are an important strategy for driving footfall and sales, however, they can create more unpredictable demand patterns, not only for the products being promoted but also for other products due to cannibalisation. Higher unpredictability can in turn lead to over production and waste, particularly for products with short shelf-life. The research revealed that different promotion mechanics and practices can influence how much variability is created and that having clear processes for managing promotions and following them is critical.

     Promotions can also increase household waste as customers might buy unusually large quantities of product. This “forward buying” can lead to waste, particularly when product shelf-life is short.

- **Forecasting (37):** Poor forecasting was one of the most common issues identified during the interviews as a cause of waste. However, estimating the demand for a product is a complex and inherently inaccurate task which can be affected by many factors, such as weather, seasonality, marketing campaigns, product launches, promotions and special occasions like Christmas and Easter.

  The research showed that a variety of forecasting practices exist in the industry, with some companies using a scientific approach while others use more informal methods. Improving forecasting practices can reduce forecast error, however, it has to be recognised that uncertainty will continue to exist and that forecast error cannot be eliminated.

- **Performance measurement (73):** The emphasis in the industry appears to be on cost, efficiency and availability. Although waste has an impact on all of these factors, it is not usually a key performance measure and it can be sacrificed at the expense of other performance indicators. For instance most mainstream retailers have policies of only accepting product with a high proportion of shelf-life remaining (usually over 70%). This is particularly problematic for own label producers who are unable to sell the product through other channels, such as discount retailers.

- **Packaging (15):** Packaging can affect waste in two different ways. On the one hand, it has a positive impact on waste because it protects the products from damage and can help to extend the shelf-life of some products. On the other hand, packaging will at some point go to waste, either in the supply chain or at the point of consumption, so excessive packaging is to be avoided. From a waste point of view, the decisions of how much packaging and what kind of packaging to use are critical. Another related issue involves changes to packaging and labelling for marketing reasons which can cause packing waste, because packaging is usually bought in large quantities, well in advance of production.

- **Cold chain management (63):** Cold chains can help to maintaining certain products in good state and avoid spoilage. Cold chain abuse, cause by equipment failure or poor processes, will inevitably cause waste. The research revealed that failure in maintaining the cold chain can have a severe impact on waste, but these situations are relatively rare.

- **Training (16):** The research revealed that in some cases people do not follow procedures for stacking, shelving and stock rotation, all of which can lead to waste. This issue appears to be more prevalent during the Christmas period when temporary labour is hired to cope with high demand.

- **Quality management (91):** Quality issues can lead to rejections and even product recalls. Rejects in particular appear to be prevalent in the fruits and vegetables sector where product quality can be variable, particularly at the beginning and end of seasons. While quality issues can lead to waste, the loss of product quality appears to be more important to the companies than the waste created.

Product recalls are relatively rare events. However, when they occur they are likely to generate large amounts of waste, particularly for products with long shelf-life since they are likely to have more stock in the pipeline.

5.4. Good practices

The research revealed that certain companies were better at dealing with the root causes of waste than others. Although it is not possible to claim we have identified best practices, we can highlight "good practices" which are currently being used to reduce waste in the food and retail industries. Each of the good practices identified are briefly described below.

- **Accountability and Culture:** It was found that having clear responsibilities for waste management at different levels (corporate, facility, process) is a starting point for creating a culture of waste reduction. Companies with clear responsibilities tend to have a robust performance measurement system for waste and this is usually linked to targets and in some cases incentives. Measuring waste performance helps to ensure that processes get managed from a waste perspective and supports other efforts such a training and investment aimed at reducing waste.
- **Collaborative Activities:** The research revealed that efforts such as Collaborative Planning Forecasting and Replenishment (CPFR), vendor managed or co-managed inventory (VMI/CMI), sharing of sales data and the use of "implants" working at the customer's facilities can have a significant impact in reducing forecasting error and consequently on waste. Nevertheless, some companies admitted that this kind of activities also require high investments in time and money.
- **Forecasting:** The use of forecasting techniques and software in the industry is variable; while some companies put great emphasis on using sophisticated statistical methods, others follow a relatively informal approach. Good practices in terms of forecasting, such as the use of dedicated software and the associated statistical techniques, can help reduce forecasting error, helping to reduce waste and improve availability.
- **Promotions:** It was found that promotions can cause more variability in demand leading to waste, particularly for products with short shelf-life, however some promotions can also prevent waste by moving product swiftly when there is a glut. While most companies have clear processes for managing promotions, it was found that some are much better at following these processes than others. Good practices in promotions management included clear processes that are followed rigorously, joint analysis of promotions throughout their lifecycle and good understanding of the impact of different promotions mechanics on waste and availability.
- **Process efficiency and effectiveness:** Efforts to reduce lead-times with approaches such as direct deliveries are cross-docking are examples of process management that can reduce waste and increase home life. Furthermore effective stock rotation and stock information management have also shown to

reduce waste along the supply chain. Finally, it was found that poor product handling can have an impact on waste, although interviewers claimed most retailers have gradually improved handling of delicate products.

- **Cold chain management:** The case studies revealed that some organisations are better at maintaining the integrity of the cold chain, partly through better and more regular maintenance of refrigeration equipment and partly through technologies that allow them to monitor the temperature along the chain.
- **Packaging:** Packaging helps to protect the product and in some cases extend its shelf-life, reducing waste as a result. Good practices in primary packaging are around managing this trade-off between volume of packaging and protection to the product. In some cases it was found that the extension of shelf-life, made possible by packaging technologies, allowed companies to change their entire supply chain strategy. In terms of secondary and tertiary packaging, we found good practices in the use of trays and other re-usable units help to reduce waste.
- **Reduce, Reuse, Recycle:** The research revealed that good companies follow the hierarchy of waste approach to minimise waste. Firstly, they try to reduce waste levels by applying many of the approaches mentioned above. In order to avoid waste, many companies "reuse" the product with limited shelf-life left by using other routes to market, such as discounters or wholesalers, even charities. Some organisations also find alternative uses for the product, such as animal feed, composting and energy generation. Recycling, was also used by a number of organisations involved in the study, particularly for packaging materials, such as cardboard and some plastics. However, recycling requires product separation and only a few organisations in the study had the right equipment and personnel to separate the product.

6. Conclusions and recommendations

The research indicates that average waste generated between suppliers and retailers ranges between 0.1% and 10%. Out of the 20 cases, ten had waste figures below 3% and only one had figures exceeding 7%. However, we found that in extreme cases, during short periods, waste for some products can be as high as 30%. Nevertheless, it is possible to conclude that waste levels between food manufacturers and retailers are considerably lower to those reported by WRAP (2008) on household waste which amount to about 30% of all purchases (although about 20% of avoidable food waste).

The majority of products with high and very-high waste have short shelf-life (less than two weeks), such as meat, fruits and vegetables. Similarly the majority of products with long shelf-lives (more than two months), such as ice cream, pasta sauces and beverages tend to have very-low levels of waste. However, it is important to note that not all products with short shelf-lives have high levels of waste, several products, such as milk, cooked poultry and potatoes have levels of waste lower than 3%. These products however, have relatively stable demand patterns throughout the year, as they are not substantially affected by factors like seasonality, weather and promotions. This is an important finding because it shows that the causes are dependent; it is not short shelf-life or the demand variability that cause the waste, but the combination of the two. This makes it impossible to attribute specific figures of waste to either of these causes.

The analysis of root-causes helped to identify three groups of issues affecting waste: (1) Mega-trends, which are consumer and industry factors that affect waste, for example increasing demand for fresh products; (2) Natural constraints, which are factors associated with the nature of the products that can affect waste such as shelf-life and (3) Management root-causes which are factors affecting waste on which management practices have a direct impact. Nine management root-causes were identified: waste management responsibilities, information sharing, promotions management, forecasting, performance measurement, packaging, cold chain management, quality management and training.

The identification of root-causes of waste and good practices in the industry was used to produce a series of recommendations which can help organisations improve the way they manage waste. These recommendations are outlined below:

- **Ensure there is accountability for waste**: Clear accountability is a prerequisite for managing waste. Organizations that have a person responsible for waste management tend to have a much better understanding of the scale and causes of the waste problem. This understanding is a first step for reducing waste.
- **Promote a culture of waste reduction:** The case studies revealed that some organisations promoted a culture of waste reduction and this culture was driving all other activities in the organisation, such as training, performance measurement and incentives.

- **Embark in collaborative activities:** Poor information sharing and lack of trust among supply chain partners can lead to waste. The case studies showed that some retailers are open to sharing information with their suppliers and in some cases they can even have employees form the supplier (implant) working on site, so that they can be in close communications. This kind of practices have proved to be effective in reducing forecasting error and hence waste, however, they can also expensive since they demand considerable resources from both suppliers and retailers.
- **Analyse promotions more closely and consider the impact on waste**: Poor promotional practices can create waste when sales do not achieve the expected demand, particularly in the case of products with short shelf-life. Understanding the impact of different promotion mechanics and working together using collaborative approaches can help to minimise the negative impact of promotions. In some cases, promotions can event help to reduce waste by helping to move product that otherwise would not reach the consumer.
- **Be more analytical about forecasting**: Although forecasts will never be perfectly accurate it is possible to reduce forecast error by using statistical techniques supported by information systems. From the case studies it appears that some retailers have an analytic approach to forecasting while others rely on more informal approaches. Given the impact that accurate forecasting can have on availability and waste, investing in forecasting methods appears to be a fruitful strategy.
- **Manage process efficiently and effectively**: The way processes are managed can affect waste at all stages in the chain, including the home. This involves efforts to reduce lead-times to increase product home life and discipline to ensure products are not damaged along the chain and that stock rotation is managed appropriately. Furthermore, it can also include efforts to extend shelf-life through improvements in technology and understanding of the microbiological, biochemical and physical changes that occur to a product through the supply chain and how these can be mitigated against or at least minimised/delayed.
- **Maintain the cold chain**: Interruptions to the cold chain can be caused by a failure in refrigeration equipment at any stage of the chain or by poor process management. Investments in both equipment maintenance and process management to reduce cold chain abuse can be paid back through reductions in waste, although this needs to be quantified.
- **Consider the natural characteristics of the product:** Some products, particularly fresh fruits and vegetables, are subject to natural variability and retailers and producers should to make allowances for variations during the season in order to reduce waste. For example, the use of flexible data code management to reflect seasons and state of product would have a direct impact on waste.
- **Use packaging effectively:** Packaging plays a dual role in terms of waste; on the one hand it protects the product from damage and can help to extend its

shelf-life, having a positive effect on waste. On the other, the amount of packaging on a product has a direct impact on household waste and to some degree on waste generated at other stages in the chain. Organisations need to look closely at packaging and decide what the right balance for each product is.

- **Reduce, Reuse, Recycle**: A number of alternatives exist to divert waste to landfill. Many organisations look for alternative markets, such as discounters, wholesalers, charities, animal feed, composting and energy generation. Recycling, particularly for packaging materials, is now a common practice for many. Using these alternatives not only compensates for some of the losses of not selling the product at full price, but also reduces waste to landfill.

Waste reduction should be a priority for organisations in the food industry, not only because waste represents an economic loss for the companies involved, but also because it has an environmental impact. Nevertheless, there are some areas where other organisations, such as universities, government and NGOs can support through further research and dissemination. These are:

- **To support data collection on waste:** many organisations do not collect waste data systematically and others are not willing to share this data openly. An alternative would be for an external organisation to establish a system for regular waste measurement across the UK. This would allow the analysis of national and regional trends as well as making possible the use of targets. At a company level, having national statistics on food waste could be used as a benchmark to promote continuous improvement. Current projects by WRAP on baseline data and resource maps could be a starting point for the continuous monitoring of food waste across the supply chain.
- **To promote discussion and dissemination:** organisations like WRAP and Envirowise are making great efforts raise awareness about waste and to identify and promote good practices in waste management. Nevertheless, this research shows that awareness about the impact of waste is still limited.
- **To support technology transfer:** As discussed in this report, many areas such as cold chain technologies, process management, packaging technologies and anaerobic digestion can be developed and improved. Technology transfer programmes, supported by research councils, government departments and universities are already in place, and our research suggest this kind of programmes should continue.
- **To support approaches to incentivise alternatives to landfill**: Sending food to landfill is costly from an economic and from an environmental perspective. Many alternatives to landfill exist, from the use charities such as Fareshare through the generation of energy from waste, however for many companies the incentives for using these alternatives are not sufficient. The impact of different approaches to disincentivise the use of landfill, such as the use of taxation and bans on landfill, should be researched further.

7. References

Barratt, M. and Oliveira, A. (2001), "Exploring the experiences of collaborative planning initiatives", International Journal of Physical Distribution & Logistics Management, vol. 31, no. 4.

BBC (2008), Stop wasting food, Brown urging, available at: http://news.bbc.co.uk/1/hi/uk_politics/7492573.stm (accessed 07/07/09).

BBSRC (2009) Future directions in research relating to food security, available from http://www.bbsrc.ac.uk/ organisation/policies/ reviews/consultations/0905_food_security_consultation.pdf, last viewed 28/07/09

Biffaward (2006) The mass balance movement: the definitive reference for resource flows within the UK environmental economy, Biffaward, available from http://www.massbalance.org/resource/massbalance, last visited 01/07/09

Binyon, S. (2007), "Environwise", in Food and Drink Federation (ed.), Reducing and Managing Waste in the Food Industry, 25th April, Food and Drink Federation.

Binyon, S. (2007), "Envirowise", in Food and Drink Federation (ed.), Reducing and Managing Waste in the Food Industry, 25th April, Food and Drink Federation.

Bourlakis, M. A. and Weightman, P. W. (2004), "Introduction to the UK Food Supply Chain", in Bourlakis, M. A. and Weightman, P. W. (eds.) Food Supply Chain Management 1st ed, Blackwell Publishing, Cornwall, pp. 1-10.

Brokman, B. K. and Morgan, R. M. (1999), "The evolution of managerial innovations in distribution: what prospects for ECR?", International Journal of Retail & Distribution Management, vol. 27, no. 10, pp. 397-408.

Cabinet Office (2008), Food: an analysis of the issues, The Strategy Unit, London.

Cabinet Office (2008), Food: an analysis of the issues, The Strategy Unit, London.

Cachon, G. P. and Fisher, M. (2000), "Supply Chain Inventory Management and the Value of Shared Information", Management Science, vol. 46, no. 8, pp. 1032.

Cerovic, M. (1998), Global Airport Retailing, , Business Insights, London.

Clarke, R. (2008), "The Influence of Product and Packaging Characteristics on Passive RFID Readability", in Kerry, J. P. and Butler, P. (eds.) Smart Packaging Technologies for Fast Moving COnsumer Goods, 1st ed, John Wiley and Sons, Chichester, UK, pp. 167-195.

Coma, V. (2008), "Bioactive packaging technologies for extended shelf life of meat-based products", Meat Science, vol. 78, no. 1-2, pp. 90-103.

C-Tech Innovation (2004), United Kingdom Food and Drink Processing - Mass Balance, Biffaward.

C-Tech Innovation Ltd (2004), United Kingdom Food and Drink Processing - Mass Balance, Biffaward.

Defra (2001), Farming: Policy - Sustainable farming and food strategy, Defra, London.

Defra (2006), Food Industry Sustainability Strategy, PB 11649, DEFRA, London, UK.

Defra (2006), Food Industry Sustainability Strategy, PB 11649, DEFRA, London, UK.

Defra (2007a), Report of the Food Industry Sustainability Strategy Champions' Group on Waste, Department for Environment, Food and Rural Affairs May 2007, DTI, London.

Defra (2007b), Waste Strategy for England 2007, cm 7086, Defra, London.

Defra (2007c) Food Statistics Pocketbook 2007, Defra, London, available from https://statistics.defra.gov.uk/esg/publications/pocketstats/foodpocketstats/fsiyp.pdf (last visited, 01/07/09)

Defra (2008), Farming and Food Brief, Defra, London.

Defra (2008), Farming and Food Brief, Defra, London.

Disney, S. M. and Towill, D. R. (2003), "On the bullwhip and inventory variance produced by an ordering policy", Omega, vol. 31, no. 3, pp. 157-167.

ECRE (2008), ECR Europe, available at: www.ecrnet.org (accessed 10/09/2008).

Egels-Zandén, N. and Wahlqvist, E. (2007), "Post-Partnership Strategies for Defining Corporate Responsibility: The Business Social Compliance Initiative", Journal of Business Ethics, vol. 70, no. 2, pp. 175-189.

Environmental Protection Act 1990 (1990), Legislation ed., UK.

Envirowise (2002) Profiting from waste reduction in retail stores, Envirowise 66325 (available from www.envirowise.gov.uk, 11/02/08)Ethical Corporation (2006), The Sustainability of European Food Supply Chains, . EU, 1991

Ethical Corporation (2006), The Sustainability of European Food Supply Chains, .

EU (1991) EU Council Directive 75/442/EEC, amended by Council Directive 91/156/EEC art. 1(a)

Fearne, A., Duffy, R. and Hornibrook, S. (2005), "Justice in UK supermarket buyer-supplier relationships: an empirical analysis", International Journal of Retail & Distribution Management, vol. 33, no. 8, pp. 570-582.

Fellows, P. (2000), Food Processing Technology, Principles and Practice, 2nd Edition ed, Woodhead Publishing Limited, Cambridge, UK.

Fenn, D. (2007), Food Industry, Keynote, Online.

Fernie, J. and Sparks, L. (2004), "Retail logistics: changes and challenges", in Fernie, J. and Sparks, L. (eds.) Logistics and Retail Management 1st ed, Kogan Page Limited, London, pp. 1-25.

Fisher, M. L., Hammond, J. H., Obermeyer, W. R. and Raman, A. (1994), "Making Supply Meet Demand in an Uncertain World", Harvard Business Review, vol. 72, no. 3, pp. 83-93.

Food and Drink Federation (2007), "Reducing and Managing Waste in the Food Industry", 25th April 2007.

Geary, S., Disney, S. M. and Towill, D. R. (2006), "On bullwhip in supply chains—historical review, present practice and expected future impact", International Journal of Production Economics, vol. 101, no. 1, pp. 2-18.

Graafland, J., van de Ven, Bert and Stoffele, N. (2003), "Strategies and Instruments for Organising CSR by Small and Large Businesses in the Netherlands", Journal of Business Ethics, vol. 47, no. 1, pp. 45-60.

Green, A. and Johnston, N. (2004), "Food Surplus; Reduction, Recovery and Recycle", in Waldron, K., Faulds, C. and Smith, A. (eds.), Total Foods, 25/04/04, http://www.totalfood2004.com/johnston_files/frame.htm, IFR Norwich, p. 35.

Green, A. and Johnston, N. (2004), "Food Surplus; Reduction, Recovery and Recycle", in Waldron, K., Faulds, C. and Smith, A. (eds.), Total Foods, 25/04/04, http://www.totalfood2004.com/johnston_files/frame.htm, IFR Norwich, p. 35.

Hogg, D., Barth, J., Scheliss, K. and Favoino, E. (2007), Dealing with food waste in the UK. Eunomia Research and Consulting, London.

Hogg, D., Barth, J., Scheliss, K. and Favoino, E. (2007), Dealing with food waste in the UK. Eunomia Research and Consulting, London.

Hughes, A., Buttle, M. and Wrigley, N. (2007), "Organisational geographies of corporate responsibility: a UK-US comparison of retailers' ethical trading initiatives", [J Econ Geogr]IS THIS BIT CORRECT?, vol. 7, no. 4, pp. 491-513.

Hughes, S. (March-April 2006), "Revise Your Ethics Policy, Reinvigorate Your Program", vol. 9, pp. 31-32(2).

Hurme, E. and Ahvenainen, R. (1996), "Active and Smart Packaging of Ready Made Foods", in Ohlsson, T., Ahvenainen, R. and Mattila-Sandholm, T. (eds.) Minimal Processing and Ready Made Foods, 1st ed, Goteburg, SIK, pp. 169-182.

IGD (2007), Retail Logistics, , IGD, Watford, UK.

Kerry, J. P. and Butler, P. (eds.) (2008), Smart Packaging Technologies for fast Moving Consumer Goods, 1st ed, John Wiley & Sons ltd., Chichester UK.

Kerry, J. P., O'Grady, M. N. and Hogan, S. A. (2006), "Past, current and potential utilisation of active and intelligent packaging systems for meat and muscle-based products: A review", Meat Science, vol. 74, no. 1, pp. 113-130.

Kotzab, H. (1999), "Improving supply chain performance by efficient consumer response? A critical comparison of existing ECR approaches", Journal of Business & Industrial Marketing, vol. 14, no. 5/6.

Lee, H. L., So, K. C. and Tang, C. S. (2000), "The Value of Information Sharing in a Two-Level Supply Chain", Management Science, vol. 46, no. 5, pp. 626.

Lee, H., Padmanabhan, V. Whang, S. (1997a) Information Distortion in the Supply Chain: The Bullwhip Effect, Management Science, Vol. 43, No. 4, pp. 546-548

Lee, H., Padmanabhan, V. Whang, S. (1997b) The bullwhip effect in supply chains, Sloan Management Review, Vol. 38, No. 3, pp. 93-102

Lyons, T. (2008), Tesco's plot to counter Aldi effect. The Sunday Times, 13 July.

Lyons, T. (2008), Tesco's plot to counter Aldi effect. The Sunday Times, 13 July.

Mena, C. (2008), Waste in the Food Chain (unpublished Workshop Presentation), Cranfield University.

Mintel (1999), Wholesaling and Cash and Carry, Mintel International Group Limited, London.

Mintel (2007), Food Retailing, Mintel, London.

Mintel (2007), Food Retailing, Mintel, London.

NetRegs (2008), NetRegs homepage, available at: http://www.netregs.gov.uk/netregs/ (accessed 09/04).

OECD/Eurostat (2005) Environmental Protection Expenditure and Revenue Joint Questionnaire/ SERIEE Environmental Protection Expenditure Account: Conversion Guidelines, Luxemburg Office for Official Publications of the European Communities (available from http://epp.eurostat.ec.europa.eu/cache/ ITY_OFFPUB/KS-EC-05-001/EN/KS-EC-05-001-EN.PDF; visited 23/06/09)

OECD/Eurostat (2005) Environmental Protection Expenditure and Revenue Joint Questionnaire/ SERIEE Environmental Protection Expenditure Account: Conversion Guidelines, Luxemburg Office for Official Publications of the European Communities (available from http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-EC-05-001/EN/KS-EC-05-001-EN.PDF; last visited 23/06/09)

ONS (2008), UK Statistics Authority, available at: http://www.statistics.gov.uk/ (accessed 10/09/2008).

Pretious, M. and Love, M. (2006), "Sourcing ethics and the global market: The case of the UK retail clothing sector", International Journal of Retail & Distribution Management, vol. 34, no. 12, pp. 892-903.

Robertson, G. L. (2006), Food Packaging - Principles and Practice, 2nd ed, CRC Press, Boca Ranton, Fl, USA.

Sivertsvik, M., Rosnes, J. T. and Bergslinen, H. (2002), "Modified Atmosphere Packaging", in Ohlsson, T. and Bengtsson, N. (eds.) Minimal Processing Technologies in the Food Industry, 1st ed, Woodhead Publishing, UK, pp. 61-86.

Smith, D. and Sparks, L. (2004), "Temperature Controlled Supply Chains", in Bourlakis, M. A. and Weightman, P. W. (eds.) Food Supply Chain Management 1st ed, Blackwell Publishing Limited, Cornwall, pp. 179-198.

Stank, T. P., Daugherty, P. J. and Autry, C. W. (1999), "Collaborative planning: supporting automatic replenishment programs", Supply Chain Management: An International Journal, vol. 4, no. 2.

TESCO (2007), Recycling and Waste, available at: http://www.tesco.com/greenerliving/what_we_are_doing/recycling_waste/default.page (accessed 26/08/08).

The Animal By-Products (Amendment) (England) Order 2001 (2001), Statutory Instrument ed., UK.

The Animal By-Products Order 1999 (1999), Statutory Instrument ed., UK.

Tompkins Associates (2001), Food and Beverage Industry Report, Tompkins Associates, London.

VICS (2008), Collaborative Planning Forecasting and Replenishment Voluntary Guidelines, available at: http://www.cpfr.org/Guidelines.html (accessed 10/09/2008).

Vidal, J. (15th April 2005), More than 30% of Our Food is Thrown Away - and it's Costing Billions a Year.

Wood, S., Adams, R., Lowe, M. and Neely, A. (2008), A Scoping Study of Contemporary and Future Challenges in the UK Retail Sector, , EPSRC Business Engagement Project, London.

WRAP (2007), Understanding Food Waste.

WRAP (2007), Understanding Food Waste.

WRAP (2008), The Courtauld Commitment, available at: http://www.wrap.org.uk/retail/courtauld_commitment/index.html (accessed 26/08/08).

WRAP (2008), The Courtauld Commitment, available at: http://www.wrap.org.uk/retail/courtauld_commitment/index.html (accessed 26/08/08).

WRAP (2009) Courtauld Commitment signatories - May 2009 (available from http://www.wrap.org.uk/downloads/Courtauld_Commitment_signatories_list_6_May_09.7fb606d3.6250.pdf, last visited 23/06/09

WRAP (2009) Courtauld Commitment signatories - May 2009 (available from http://www.wrap.org.uk/downloads/Courtauld_Commitment_signatories_list_6_May_09.7fb606d3.6250.pdf, last visited 23/06/09

8. Appendices

Appendix 1: Data Collection Protocol

The following table presents the stages of the interview process and has been designed as a guide to ensure that all interviews are conducted in a consistent and systematic way.

Before	• Interviews should ideally be conducted face-to-face • Arrange suitable time (interviews should last around 1-1.5 hrs) • Arrange suitable place (make sure there will be a private area to conduct the interviews) • Make sure participants are aware of the purpose and benefits of the interview and are comfortable with providing data • Define waste as "Any substance or object the holder discards, intends to discard or is required to discard" based on Waste Framework Directive (European Directive 2006/12/EC) • Send interview protocol in advance of interview • Two researchers should attend each interview for triangulation purposes
During	• Introduce project and researchers • Outline purpose of the interview and clarify scope, objectives and benefits • Ensure anonymity and confidentiality or information • Complete cover sheet (Section 1) • Go through questions in sections 2 and 3 and take notes as appropriate. Questions should serve as a guide and can be adapted or omitted depending on the circumstances. It is also possible to ask additional questions if necessary. • Summarize main points • Ask if there are any additional leads or sources of information • Ask if there are any additional questions and thank for time
After	• Complete interview summary form (Section 4). Discussed by both researchers. • Follow any additional leads • Prepare an interview report • Incorporate data into secure database • Archive interview notes in secure location

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1. COVER SHEET

Company ***(optional)***		**Date**	**Time**	**Interviewer**
Name ***(optional)***	**E-mail** ***(optional)***			**Telephone** ***(optional)***
Title and responsibilities ***(optional)***				
1.0 Who is responsible for waste in the organisation?				
1.1 Product Reviewed				
1.2 Brief description of Product				
1.3 Scope: □ **Manufacture** □ **Logistics** □ **Retail**				
1.4 Product Type □ **Fast Moving Goods (FMG)** □ **Chilled / Fresh Meats** □ **Frozen**	□ **Slow Moving Goods (SMG)** □ **Produce** □ **Beer, Wine and Spirits**			
1.5 Product shelf life (days)				
1.6 Lead time (hours from order to delivery)				
1.7 Demand Variability (comments on seasonality, cyclicality and promotions)				
1.8 Average stock cover (days):				
1.9 Total production volume (per year):				
1.10 Percentage of wasted product (over a year)				
1.11 Tonnage of wasted product (per year):				

2. CAUSES OF WASTE

2.1 What are the main causes of waste for this product?
2.2 What is the impact of forecasting practices on waste?
2.3 What is the impact of information sharing on waste?
2.4 What is the impact of promotions on waste for this product?
2.5 What is the impact of lead-times on waste?
2.6 What is the impact of shelf life policies on waste? (i.e. proportion of shelf life accepted)
2.7 What is the target stock level for this product? 2.7.1 What is the impact of safety stock level policies on waste?
2.8 Are there any specific stacking and shelving polices for this product? 2.8.1 What is the impact of these polices on waste?
2.9 What are the penalties for not delivering on-time in-full (OTIF)? 2.9.1 What is the impact of such policies on waste?
2.10 Are there any specific characteristics of this product that make it more susceptible to creating waste?
2.11 What is the impact of product damage on waste for this product?
2.12 What is the impact of packaging design on waste? 2.12.1 What kind of intermediate packaging is used for this product? 2.12.2 What is the impact of "ready for shelf" packaging on waste?
2.13 What would be the impact of a product recall and emergency product withdrawals (EPWs) on wasted product?
2.14 What is the impact of weather changes on waste for this product?
2.15.1 What would be the impact on waste of a catastrophic failure on warehousing equipment? 2.15.2 What would be the impact on waste of a catastrophic failure on transportation equipment?
2.16 What is the impact of seasonality on waste for this product?
2.17 Have we missed any other important cause of waste for this product?

3. Destination of waste

3.1 What happens to waste of damaged product?
3.2 What happens to waste of product that exceeds it shelf life?
3.3 What happens to product that exceeds the proportion of shelf life demanded by retailers but it is still safe to eat?
3.4 What happens to packaging waste (i.e. intermediate packaging)?

4. **SUMMARY FORM**

4.1 Interview Summary: *A brief summary of the interview and impressions*
4.2 Supporting documents collected: *A list of the documents collected in the interview*
4.3 Pending documents: *A list of documents pending collection*
4.4 Additional sources of information: *Reference to other sources of information (people, documents, computer systems)*