Final Report

Reducing food waste by extending product life

The objectives of this project were to explore ways of providing consumers with products that have increased product life - without compromising safety or quality and without changes to products or packaging - and to develop the business case, in terms of waste prevention, for change.

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Executive summary

The purpose of this study is to demonstrate the business case for preventing food waste by reviewing and extending product life, even by a small amount of just one day. We identify and discuss the ways that this could be achieved, for a selected range of products, without compromising product safety or quality, or needing to make any changes to packaging or product formulations.

The evidence base for our work comprised sampling 23,299 products on retail shelves and 29 interviews with retailers, manufacturers and trade associations. We selected 10 products that feature in typical shopping baskets as the focus of this work. These products also have high levels of waste in the home and include short shelf life items that provide a good opportunity for examining the impact of a small increase in product life on food waste.

Product life expiry is a key reason for food waste. It is not possible for retailers to sell products after their 'use by' date and products that approach these dates are usually marked down in price for sale. If this is not effective, then products will enter the waste stream. Manufacturers have more flexibility, for example to re-work material, but orders that are rejected or cancelled close to their product life could lead to waste. Households also waste products because they have 'not been used in time'; our research shows that this is the top reason given, which will include date code expiry. In this project we have estimated that some 1.3 – 2.6 million tonnes of food waste - with a value of between £3-6bn - arises in the supply chain and in the home because the product date code has expired. The majority of this waste arises in our homes; bearing this in mind, WRAP recommend that any extension of product life achieved should be passed on to the consumer wherever possible.

This work has demonstrated that it is feasible to challenge existing product life setting protocols and potentially add one day to a wide range of products. A small increase in product life of one day is more likely to impact behaviour for products that have a short life, for example between 3-12 days, than for products that have, say, in excess of 30 days life, simply because it gives proportionately more time for a sale or for the product to be used in the home. The evidence also suggests that products with a short life are likely to lead to more waste than those with a longer life.

Using the results from our sample of 10 products, extrapolated across all food items, we have estimated that an increase of just one day could help prevent up to 0.2 million tonnes of household food waste, or just less than 5% of avoidable food waste in the UK, potentially giving a saving to consumers approaching £0.6bn on an annual basis. These estimates also indicate a direct business benefit for retailers of around £0.1bn in waste prevention alone; increased sales from improved on-shelf availability could be added to this potential benefit. Businesses might also benefit from households trading up to higher value products by using the savings they gain from wasting less food.

The evidence from this project shows that there are opportunities to reduce food waste and its associated cost, by extending product life and that there are simple ways to do this without the need to make changes to packaging or product formulations. We have identified five key ways for retailers and manufacturers to act on this opportunity:

Challenging safety or quality buffers that are put in place, as these could be overly cautious. We found 'buffers', which vary in significance, are put in place between the product life that is actually specified for the product and the maximum life the product stays safe or retains its quality. For the products included on our study, there is the greatest opportunity to challenge the product life of potatoes, apples, mince and sliced ham in this

way. These products are in the main retailer 'own label' ranges and thereby represent a significant opportunity for retailers to help consumers reduce their waste. We recognise that for certain products, product formulation and processing methods are significant factors that can also extend the maximum life.

Developing more standard approaches to open life setting. We found that open life guidance is widespread across many product categories (for example, 'once opened consume within x days'). Such guidance was applied for both quality and safety purposes, and the methodology used to specify the time period, for example, 2 days, varied. It is our recommendation that open life guidance is only used for products where food safety is a potential issue and not when the limiting factor is quality. We also advocate a more consistent approach to open life setting practices by retailers and manufacturers, to avoid any potential confusion and ensure that the consumer is given more consistent advice for comparable products.

Increasing the product life available for consumers through supply chain improvements. We found that shoppers are faced with a wide range of available life for the same product on shelf at a particular point in time. So the product life available on shelf at the time of purchase can range from short dated stock (with product life ending the same day on which it is bought) to product with the full length of life (delivered on the same day as it was produced). For example, for sliced ham our study showed that this difference can range from 1 day of available life to 23 days of available life, on shelf at the same time. The reasons why this can arise are complex and include the shelf replenishment process, including better discipline in stock rotation and adherence to mark down protocols. Retailers' systems typically cannot distinguish the product life of products that are sold, because bar codes don't record this information.

Benchmarking the delivery performance, with respect to remaining life, of products when they arrive at retailers' depots in order to provide consumers with more available life more of the time. We found that receipt into retailer depot is a key performance measure, as typically a 75% 'minimum life on receipt' (MLOR) is regarded as an industry standard. This means that at least 75% of the life of the product should be available to retailers, which they then pass on to consumers less the time spent in their replenishment systems. In supermarkets we found that many retailers are now requiring an 85% standard, which will help provide consumers with increased life though this new standard is by no means universal. We also found that performance against the 75% standard varied from the low 40s to the high 90s percentages. This suggests there is scope to provide consumers with more available life more regularly by bringing the lowest performance up to the standards achieved by the best performance. However, we are not advocating that deliveries which don't meet the MLOR requirement are rejected, rather that daily negotiations take place backed up by collaborative effort to improve performance. We also found the 75% standard varies by retail channel. In the convenience sector, particularly in relation to symbol groups (independent retailers and outlets part of a branded group, for example, a franchise), which have seen growth over the recent past, the standard is typically lower and the performance more varied. This means that consumers, on average, will have less available life when buying through convenience stores. This may be acceptable given the nature of convenience shopping, but if the sector keeps on growing then there may be an adverse consequence for household food waste levels.

Reducing inconsistency in the use of date codes, which causes confusion among consumers and can lead to poor decision making in the home. We found that 'display until' codes are still in use (around 12% of the products surveyed) and some examples were found on all but one of the products studied, although this study and our previous research shows that the industry has made considerable progress in moving away from using this

type of coding. No evidence of 'display until' codes was found in two of the retailers surveyed, whilst for a number of other retailers evidence was only found on a small number of the products studied. Of the products surveyed, potatoes, juice, milk and sliced ham are products where 'display until' dates are still prevalent, in terms of the number of examples recorded. However these instances were recorded in only a small proportion of the retailers included in the survey. WRAP recommends the use of either 'use-by' or 'best-before' dates as the only date codes that appear on packs, in order to help prevent household food waste and enable consumers to make the most of any increased product life.

Our aim is to encourage retailers and manufacturers to use the opportunities we have identified to review and challenge how product life is set with a view to increasing life by at least one day where it is safe to do so and without compromising quality. We therefore recommend the following, to take action towards the five areas of opportunity identified:

- Retailers for own label and manufacturers of brands should review the 'total life' of all products with a focus on short shelf life or high waste products with a view to challenging the 'buffers' that are in place in order to find opportunities to compress these and extend product life;
- There should be a consistent approach across own label and brands on setting both total life and open life for comparable products;
- Retailers and manufacturers should challenge current 'open life' guidance that is on pack, in terms of length (that is number of days) and also whether it is needed at all from a food safety point of view;
- Practice shows that an 85% minimum life on receipt (MLOR) at retailers' depots is achievable and that more retailers are requiring this standard. A collaborative approach should be adopted between retailers and suppliers to improve performance, including formal recognition of the need for daily negotiations. The purpose of this being to provide consumers with more of the product life and ensure that waste in the supply chain is not increased as a result of this action;
- Retailers' protocols for stock rotation, which can lead to large date ranges on shelves, and mark down policy, which could prevent food waste, should be reviewed in light of this research;
- Manufacturers should examine ways of reducing processing times through the use of lean manufacturing principles to investigate the potential for giving consumers increased available life; for protein products improved process hygiene could also play a key role; and
- All 'display until' dates should be removed from packs leaving only' use by' or 'best before' dates and open life guidance, where appropriate; further, 'use by' dates should be confined to products where there is a safety risk and the industry should continue to work on providing improved storage, freezing and defrosting guidance on pack, accompanied by point of sale information in-store.

In the longer term, there are further opportunities, which may involve changes to products or packaging, such as the potential to test out the efficacy of new bar code systems that can record product life, and new technology like the use of thermo-chromic inks being used to help encourage consumers store products at the correct temperatures (for example in the fridge).

Retailers and manufacturers can start this review process by benchmarking their own product life performance. WRAP would be pleased to facilitate such discussions on available

life and open life using unpublished data from this study. We will also explore the potential to establish a cross industry working group to encourage and facilitate a consistent approach to product life and open life setting to take forward the recommendations in this research.

WRAP will also continue to monitor and report on date code labels, on pack guidance and open life guidance through the forthcoming Retailer Survey in 2015.

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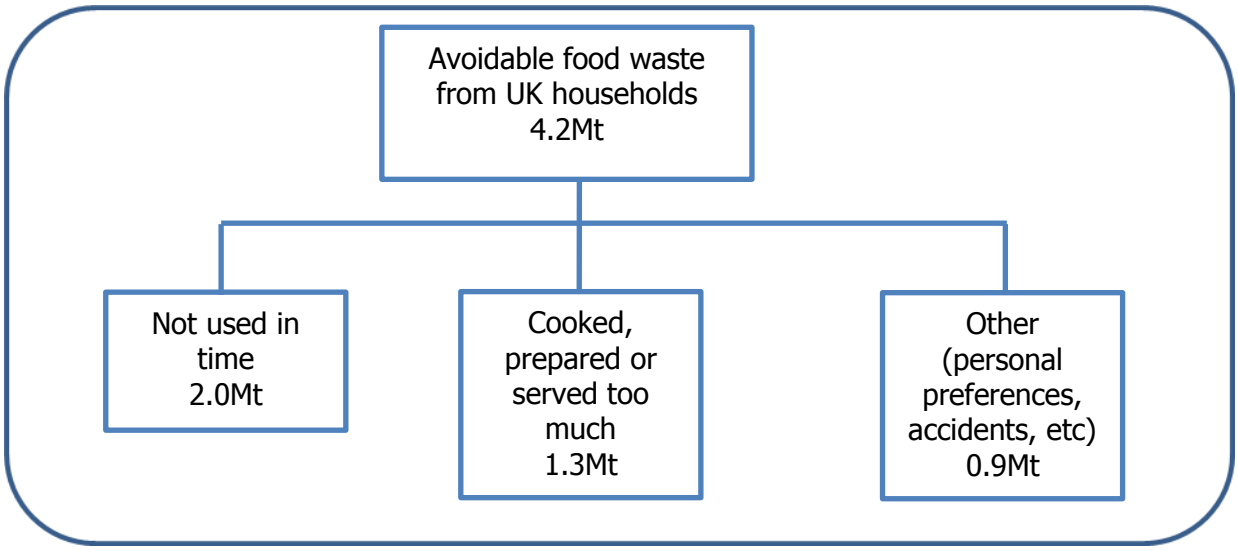
1.0 Background

WRAP has built up a comprehensive evidence base on the extent of household food waste and its causes.[1] A major cause of household food waste is products not used in time. Latest estimates show that there is 4.2 million tonnes of avoidable food waste produced annually by households (food and drink thrown away that was, at some point prior to disposal, edible) and that 2 million tonnes (48%) of food and drink are wasted because it is 'not used in time' (**Figure 1**). It is estimated[2] that the 2 million tonnes of avoidable food waste caused by product life expiry costs households £5.6 billion annually.

Figure 1: Key causes of avoidable household food waste



WRAP has also published estimates of food waste in the supply chain[3]; here the causes are also complex but are not as readily identifiable as those that result in household food waste. It is not possible to identify directly from survey data, or other sources, the proportion of supply chain food waste that is attributable to product life causes. All retailers have mark-down policies designed to encourage the sale of products before their expiry date to prevent food waste. However, despite these policies, product life as well as damage is identified as a major cause of waste in retailer systems. Product life expiry can also be a cause of waste in food manufacturing for both ingredients and final products however there is more flexibility for example to re-work material for different markets.

For a further discussion of these data and a derivation of an estimate of the amount of food waste arising related to product life expiry from households and the retail supply chain, refer to Annex 3. We estimate this quantity is in the region of 1.3 to 2.6 million tonnes, annually.

This project focuses on product life expiry as a key cause of food waste and, in particular, the impact that even a small increase in product life could have on preventing food waste. Product life is set by retailers and brand manufacturers within the framework of European legislation while, for consumers, product life can impact on choice as part of the shopping decision. Product life therefore impacts on decisions across the supply chain from manufacturing to retail to households.

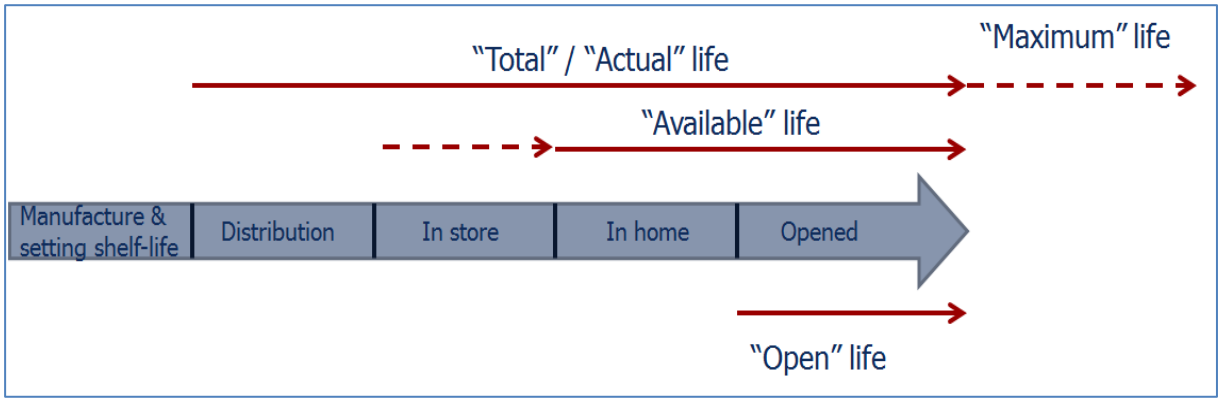
[1] *http://www.wrap.org.uk/sites/files/wrap/Food%20waste%20resource%20listing%20Apr%2014.pdf*
[2] *WRAP 'Household Food and Drink Waste in the United Kingdom' (2012)*
[3] *http://www.wrap.org.uk/sites/files/wrap/Estimates%20of%20waste%20in%20the%20food%20and%20drink%20supply%20chain_0.pdf*

WRAP has encouraged innovative approaches to extending product life; for example, through new approaches to packaging[4] as well as through product recipe changes. This project takes a different focus and explores opportunities for extending product life that do not involve such 'design' changes.

1.1 Project scope

The objectives of this project were to explore the potential benefits and the ways of providing consumers with products with increased product life without compromising safety or quality, and to develop the associated business case for change. There are a number of areas where opportunities to increase product life can be tackled, using product life definitions shown in **Figure 2**.

Figure 2: Product life definitions



- First, product life is set so as not to compromise food safety or quality. The result is that manufacturers and retailers err on the side of caution when setting product life such that the 'maximum life' (the technical, maximum product life that could be set, without compromising food safety) is generally greater than the product life that is given to products. A published feasibility study which focused on cheese and yoghurt[5] indicated that the product life of the product is, for example, 15-25% less than its maximum life. There is therefore scope across these and a wider range of products to provide additional life where the buffers are too conservative or where the protocols for setting product life are not up to date. Some retailers also make a short product life part of their 'quality positioning', for example because of 'brand standards' or perceptions of 'freshness' that could be challenged.
- Secondly, for some products, open life guidance is also provided. Open life is a time period specified, within the date code, which stipulates the period that a product should be consumed within once open. An important component of open life is that it supersedes other durability coding. This is particularly relevant to products where food safety is the primary concern. Opening a packaged product increases the safety risk to the product, as it becomes exposed to environmental contaminants. Open life is particularly important in the case of products that are packaged using modified atmosphere, gas-flushed, vacuum-sealed or contained in a self-regulating atmosphere. In these cases the atmosphere around the product is artificially controlled in order to slow the rate of deterioration and

[4] *http://www.wrap.org.uk/sites/files/wrap/Exec%20Summary%20-%20Consumer%20attitudes%20to%20food%20waste%20and%20packaging.pdf*
[5] *http://www.wrap.org.uk/content/product-life-feasibility-study-0*

prolong the product life. The product will only achieve the desired safety or quality parameters whilst in the modified environment. On opening the packaging this environment is lost, the benefit it provides is lost, and the deterioration that was arrested whilst sealed re-starts. However, there is relatively little evidence on how open life is set and whether it is set for safety or quality reasons.

- Thirdly, previous research has shown[6] that there can be substantial variation in the available life of products (the proportion of the total product life remaining to consumers) when products are bought. There may well be good reasons why the life available to consumers at point of sale differs between products that are within the same category (or close substitutes). These differences could relate to product formulation, processing methods and differences in packaging materials, for example. Different practices by retailers and manufacturers may also lead to different product life setting protocols. However these variations could also be due to supply chain practices. For example, for any given product there could be a range of different date codes stacked on shelf, or products may dwell in retailers' back store rooms, or manufacturers may set product life differently for similar batch runs.
- Fourthly, most products are delivered by manufacturers to retail depots and from there into stores. Manufacturers strive to provide retailers with products that have the maximum product life remaining[7] – this is often known as the 'minimum life on receipt' (MLOR). This is a key performance benchmark that is unlikely to be met on every occasion by every product. Improving MLOR could also result in better available life but we have kept MLOR and available life separate because problems in either potentially have different root causes and different solutions.
- Fifthly, the type of date coding used for each product is explored, since previous WRAP studies have shown an inconsistency across product categories.[8] For example, the use of 'display until' codes has been found to be confusing to the consumer and to result in the premature disposal of food and drink. Displaying 'use-by' codes instead of 'best before' codes on products that drop below an organoleptic standard with no danger to human health also adds to confusion, since many consumers are aware that 'use-by' dates relate to product safety and should not be exceeded while 'best before' dates are discretionary.

The project also set out to quantify the benefit (in terms of waste prevention) of a small increase in product life in order to provide the business case for change.

Clearly, the marginal increases in product life or open life that are the focus of this project must not compromise food safety or quality. Any increases in product life that could be achieved should be passed on in full, where possible, to the consumer in ways that don't result in waste increasing elsewhere in the supply chain.

WRAP will also continue to work with retailers and manufacturers to optimise packaging which, in many cases, can have a beneficial impact on product life.

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[6] *http://www.wrap.org.uk/sites/files/wrap/240412%20Retailer%20review%202011.pdf*

[7] *Some stock maybe short dated for a variety of reasons for example, because they have been re-worked owing to a labelling or other error.*

[8] *The date code is either in the form of a date of minimum durability ('best before' date) or a 'use by' date. When a product is, from a microbiological point of view, highly perishable and in consequence likely after a short period to constitute an immediate danger to human health it needs to carry a 'use by' date. It is now clearly referenced in article 24 to Regulation (EU) 1169/2011 that exceeding a products 'use by' date a food shall be deemed to be unsafe in accordance with Article 14(2) to (5) of Regulation (EC) No 178/2002.If after a period of time a product simply drops below an acceptable organoleptic standard (i.e. it doesn't taste very nice or the mouth feel is not what is expected) it needs to carry a 'best before' date. 'Best before' dates should be indicated by; 'Best Before' followed by the date (or an indication of where the date is printed) and the conditions that the product needs to be stored in to reach that date in an acceptable condition.*

2.0 Methodology

To provide a comprehensive and up to date evidence base, the project was split into four main steps:

- Step 1: Undertake a survey of selected products on retail shelves, repeating elements of the retail survey[9] for example on date labels and available life reported in 2012.
- Step 2: Understand the current methods and influences on setting the total life of the product, building on the feasibility study[10] into yoghurt and cheese to identify if buffers exist in a wider range of products.
- Step 3: Investigate the opportunities for increasing available life of the products on the retail shelves through examining the performance into depots.
- Step 4: Quantify the economic and environmental savings to consumers and the supply chain from a small increase in product life.

2.1 Step 1: Undertake a survey of selected products on retail shelves

Of the 2 million tonnes of products wasted by households because they were not used in time, short product life, perishable foods including fresh fruit and vegetables and salads, meat and fish, bakery and dairy account for 65% of the total in financial terms and 74% by weight. The aim was to include many of these products as well as those included in the 2011 retailer survey. There were a number of key selection criteria for products included in this research:

- high levels of consumer waste;
- current 'short' product life for example between 3-12 days;
- mixture of use-by/best before dates;
- products where purchase decisions are influenced by a high use of date labels;
- products that included open life guidance (where food safety is the main consideration); and
- 'automated purchase' (an item likely bought during every shopping trip).

Initially ten products or product groups (see Annex 1) were selected for the data collection exercise and it is on these that store data were captured; subsequently beef mince was added at the suggestion of a Courtauld signatory and this product is included for part of the analysis only.

The store data captured included: store fascia, store size, product range, on/off promotion, stock level, date types ('display until', 'use-by' and 'best before') date (available life), open life and, where possible, the date of manufacture (usually the Julian code). These data were collected across 13 stores in three locations. The top eight retailers were visited three times each (to assess busier and quieter times). All the fieldwork was undertaken between 7 and 26 October 2013.

Table 1 shows the breakdown of the samples taken by product category. 23,299 samples were captured in total across the 10 selected product categories.[11]

[9] *http://www.wrap.org.uk/content/household-food-and-drink-waste-uk-2012*
[10] *http://www.wrap.org.uk/content/product-life-feasibility-study-0*
[11] *Ready meals includes chicken Kiev and lasagne*

Table 1: Raw data collection

Product category (Number of samples recorded)											Total
Bread	Potatoes	Yoghurt	Juice	Milk	Salad	Sliced ham	Chicken breast	Pizza	Chicken Kiev	Lasagne	
4,511	1,752	1,416	3,292	3,456	1,111	2,092	2,263	1,570	1,145	691	23,299

Detailed analyses can be made of these data; for example, available life or open life by product and retailer. These data are not reported here, but can be used for benchmarking comparisons with individual retailers and manufacturers.[12]

2.2 Step 2: Understand the methods and influences for setting the total life

The primary aim of this step was to understand the processes involved in identifying and setting product life and open life. This involved investigating the current protocols used by different manufacturers and retailers for setting the total life of products in order to understand the nature and magnitude of any buffers (compared with the maximum life) and to identify the most significant opportunities for extending product life.

To achieve this, three primary phases of industry interaction were undertaken through a series of targeted telephone interviews and, in a small number of cases, face to face interviews were conducted. In total 29 interviews were conducted between October 2013 and March 2014, involving:

- retailers (3 interviews);
- trade associations (3 interviews); and
- manufacturers of the 11 identified product categories (23 interviews).

2.3 Step 3: Investigate the opportunities for increasing available life

The primary aim of this step was to understand the processes involved in moving the products through the supply chain, particularly into retail depots where product life is captured on retail data systems. All retailers require a 'minimum life on receipt' (MLOR) from their suppliers and performance at this point can be benchmarked. Data on MLOR is commercially sensitive but sufficient information was obtained to suggest that this was a potential avenue for providing stores, and thereby consumers, with products that have increased available life. We wanted to understand where and why delays might occur between retailers' depots and store shelf thereby reducing the available life for consumers.

2.4 Step 4: Quantify the economic and environmental savings

This step aimed to identify the business drivers for/against increasing product life, specifically:

- identify the main benefit metrics (other than waste prevention) that will drive retailers and manufacturers to extend product life;
- use these metrics to quantify the benefit to business; and
- quantify the benefit in terms of household waste prevention of a marginal increase in product life.

[12] *Contact WRAP directly to discuss these data sets*

To support this work, WRAP also undertook a 'business experiment' working with a major retailer and supplier in which the product life of individual products (two stock keeping units – SKUs - were in the trial which was subsequently reduced to one) was artificially changed and the impact on waste (and other metrics) was assessed. This work demonstrated that a small increase in product life reduced waste without compromising on-shelf availability and sales for the products selected. The results are reported in a case study published with this report.

While these steps were undertaken as separate data collection exercises, they all re-enforce the objectives of this project; namely, to demonstrate how a small increase in the product life that is available to households can help prevent food waste. The results have been synthesised and analysed in this report and to produce guidance for retailers and manufacturers on how they could challenge product life. So, for example, this may be achieved by providing an increase in actual life which is passed on in full to the consumer, or by providing more of the actual life to consumers because the product transfers through the supply chain more quickly or through more consistent approaches to open life setting.

Alongside this report, WRAP has published:

- case studies that demonstrate the waste prevention benefits of extending product life, and;
- a slide deck that shows for each of the individual products that were the focus of this study, the amount of avoidable household food waste and the ways in which existing product life setting arrangements could be challenged.

3.0 Results

The results are presented in five sections:

- Total life;
- Open life;
- Available life;
- Minimum life on receipt; and,
- Date code type.

This section also brings together the results for each of the products we examined in this study.

3.1 Total life

Our feasibility study on yoghurt and cheese demonstrated that retailers and manufactures err on the side of caution when setting product life – reducing the safe product life by adding a "buffer". This work has shown that similar buffers exist for other products including, juice, milk and salads for products where quality is the limiting factor and for sliced ham where the limiting factor is safety. A full review is shown in **Table 8** and Annex 2 (in which we have also brought together all the main ways in which product life could be challenged).

Temperature abuse by consumers (and potentially in the supply chain) is one reason why there is caution in setting product life. Another is that domestic refrigeration can be a key constraint. There is evidence that many domestic refrigerators are not operated between the recommended 0°C and 5°C.[13] That previous work demonstrated:

'The in-home temperature survey completed as part of this research shows that the majority of domestic refrigerators operate at a mean air temperature of around 7°C. It was apparent that a proportion of the fridges tested (14 fridges, 29% of the sample) were operating at mean air temperatures of 9°C or above. Only 14 of the 48 fridges (29% of the sample) were found to be at mean air temperatures of 5°C or less. With 34 fridges (70%) operating below 8°C.'

Of course there are many other reasons why product may not be kept in the optimum conditions including transport from the retailer to the home that need to be taken into account when setting product life. Retailers may also set lower product life for brand reasons. The perception of freshness by consumers could also be a reason why the product life is set less than either its maximum life or what would be an acceptable product life.

Table 2 shows the summary of the headline findings from the store data survey of the 10 product categories on the retail shelves.[14] This shows a number of products (including juice, lasagne, sliced ham and yoghurt) for which there is a considerable difference in the maximum and minimum total life (days). Product formulation will play a key role in causing this variation but other reasons identified above could also play a part. The mean total life for lasagne is also impacted by the inclusion of long-life products within the sample[15].

[13] *http://www.wrap.org.uk/sites/files/wrap/Reducing%20food%20waste%20through%20the%20chill%20chain.pdf*
[14] *Ready Meals includes chicken kiev and lasagne*
[15] *A small number of products in the samples, particularly for juice and a smaller number for other products, such as lasagne, are longer life products and this explains some of the larger ranges in product life in Tables 2 and 4.*

Table 2: Results of the benchmark survey for Total Life

Product	Total life (days)[16]			
	Mean	Min	Max	Range
Bread	6.8	6	10	4
Chicken breast	10	8	10	2
Chicken Kiev	9.5	8	10	2
Juice	45	12	80	68
Lasagne	25.3	12	30	18
Milk	13	11	13	2
Pizza	10.5	8	15	7
Potatoes	10	6	12	6
Salad	8.3	7	10	3
Sliced ham	20	16	30	14
Yoghurt	20	15	30	15

Annex 2 shows the detailed review of each product including the key barriers and opportunities for extending product life. (Please note: apples and mince were included in this analysis.) While potential opportunities were found for all the products, sliced ham, potatoes, apples and mince are the four products that present the greatest opportunity in respect of challenging 'excessive' buffers:

- **Sliced ham** – Of particular interest is the potential product life of cooked ham pre-slicing, which is well controlled and could be extended beyond the assigned 15 days. Improved process hygiene can then ensure up to 25 days on sliced product.
- **Potatoes** – There are solutions that could help extend life in home, such as reducing exposure to light through the use of paper bags or reducing storage light intensity. Changing consumer behaviour is also important, for example by providing consumers with clear storage guidance or by providing smaller bags.
- **Apples** – The use of an open fruit bowl at home has big impact in reducing the life of fruit, so changing consumer behaviour will help extend the life of apples, for example by encouraging refrigeration at home, helped through educating consumers via better storage instructions on pack and in-store.
- **Mince** – The biggest gains will come from minimising the microbial load on the carcase. In addition skin packing can ensure that life in store is maximised, and will allow better producer stock building and efficiency as well as give the consumer more life per se.

For these four products, the approach to 'shelf life' is led by retailers (as most are own label products) and it was noted that there is inconsistency between the approaches that retailers take.

3.2 Open Life

We found that open life guidance can take different forms. Examples include:

- Once open refrigerate below 5°C and consume within 2 days;
- Keep refrigerated below 5°C. Packaged in a protective atmosphere. Once opened keep refrigerated and consume within 2 days. Do not exceed the use by date. For use by date, see front of pack.

[16] *Total life is derived primarily from an analysis of Julian codes that appear on packs*

In some cases it is clear from the information that there is a food safety issue, while in others, this is not the case. However, because of the disparity in messaging across the industry, food safety concerns may not be well understood by the consumer. The additional guidance, for example 'refrigerate once opened' or 'store in a cool dark place' inform the conditions that are required to maintain the product in its optimum condition.

Whilst it is recognised that different products, packaging and processing conditions impact on the specific nature of open life, open life advice was also found to be inconsistent. The evidence shows that consumers are not necessarily suitably informed as to the reason for any differences between products or the reasons why the open life is set. Of the 11 products surveyed only 3 did not display any open life instruction the other 8 products had some advice regardless of whether safety or quality was the key element determining shelf life. **Table 3** below summarises the results and shows that for only 4 of the products considered was safety the limiting factor.

Table 3: Summary of the open life results

Product	Limiting factor	Total life (days)	Open life (days)
Bread	Quality	2	1
Potatoes	Quality	6	None Given
Mince	Safety	7-9	1
Juice	Mainly quality	21-30	2-4 days
Juice	Mainly quality	7-14	2-5
Milk	Quality	12-14	2-3
Salad	Quality	4-8	1
Sliced ham	Safety	21-25	2-3
Ready meals	Safety	8	1
Chicken breasts	Safety	10	1-2
Prepared food (Pizza)	Quality	6-8	None Given
Apples	Quality	5	None Given

The interviews revealed that there were also disparities in the range of justification for the on-pack information provided to the consumer. These justifications included:

- Sliced Ham – shelf life testing and replication of customer habit, or set historically;
- Mince – industry standard;
- Milk – based on history and previous information;
- Juice – shelf life testing and experimentation;
- Chicken breast- microbiological testing;
- Salad – no testing completed – product knowledge of fast respiring baby leaf.

There was no explicit reference to quality or safety, and whilst a successful transition to improved 'use-by/ best before' dates has been made for many products, the consumer is generally not aware of the specific concerns for a particular product that is, when it is safe to consume a product, and when will it be simply 'not as good'. This lack of understanding, results in a cautious consumer, whom, in the absence of clear guidance, is more likely to dispose of a product, even if it is safe to eat.

It was found that manufacturers had good knowledge of the product life extension that packaging achieved and that these were determined by microbiological studies. These were often in the form of, but not consistently, using abuse conditions designed to simulate 'in home' conditions. However for products that are packaged using modified atmospheres, the

justification for the 'open life' was varied and included: shelf life testing and replication of customer habit, set historically or considered an industry standard.

The study also found that there was scepticism by those who set product life as to whether the consumer actually followed the guidance provided. It was suggested that whilst an 'open life' may have potential to be extended by up to 50% for example in sliced ham and juice, there was no intrinsic benefit to do so, since the consumer does not necessarily follow the advice given and thus it was deemed beneficial to the manufacturer to build a robust buffer to counteract consumer behaviour. If consumers were better informed and followed open life guidance it could give manufacturers and retailers more confidence in reducing the buffers and extending open life advice.

3.3 Available life

Table 4 shows that for all product categories surveyed, the available life varied significantly with 9 of the 11 product categories having a minimum available life of zero days (products with use-by dates which would enter the waste stream that day if the product was not sold). Typically, those products with a minimum life of zero will be marked down in an attempt to encourage a quick sale. The implication of this is not only the reduced available life for the consumer (although they may have purchased the product for use that day), but also the impact on retailer margins for this product.

Table 4: Benchmark survey results on Available Life

Product	Available life (days)			
	Mean	Min	Max	Range
Bread	3.1	0	10	10
Chicken breast	4.7	0	9	9
Chicken Kiev	4.1	0	8	8
Juice	35.7	0	72	72
Lasagne	7.6	0	26	26
Milk	7.9	4	11	7
Pizza	4.5	0	8	8
Potatoes	3.7	0	8	8
Salad	3.5	0	7	7
Sliced ham	12.2	1	23	22
Yoghurt	13.7	0	27	27

The data in **Table 4** shows that, for some products (lasagne, juice, yoghurt and sliced ham), the variability of available life can be significant when compared to the average observed. The reasons for this are complicated and could include:

- different product formulations and processing methods such that the products have inherently more or less life;
- different demand characteristics including more volatile (unpredictable) demand, which results in a greater number of stock holding points in the supply chain as production runs are based on forecasts rather than actual demand;
- on-going promotions which impact across brands resulting in a loss of sales for similar products that are not being promoted;
- misalignment of shelf space and demand which can result in a large range of date coded products on shelf;
- consumer behaviour in searching out the products with the longest available life; and

- non-adherence to mark-down policies.

For all 11 products, the available life data shows that consumers face similar products with different expiry dates when they shop. This is particularly the case for the products with a longer mean and maximum available life, for example juice, yoghurt and lasagne. One of the key reasons for this broad range of dates is the need to keep shelves full to drive sales. Retailers use on-shelf availability (OSA) as a key benchmark and, increasingly, their suppliers are being judged by this metric.

The shelf replenishment process typically involves the regular 'topping up' of shelves. Some shelves have products with several date codes available to be shopped. Poor discipline in stock rotation, that is not moving the older stock to the front of the shelf, can result in these products being passed over by the consumer. This can result in the need to regularly mark down product and can result in significant levels of date-expired food waste (the major identified cause of food waste at stores) which, conversely, can impact on inventory levels and ultimately result in product being out of stock, reduced OSA and, ultimately, lost sales. Consumers themselves, of course, may shop for products with the longest life they can find on shelf. This issue of shelf replenishment is a complex area with many potential 'root causes' including:

- some product may languish at the back of store because for example pack information is unclear or hard to find with the result that it spends more time 'in stock' than on shelf;
- retailers' cannot record the product life when a product is sold because current bar codes do not provide for this information to be captured. Their replenishment systems are therefore 'blind' to the amount of product by different date codes that are on-shelf though product life can be taken into account when placing orders;
- orders may be amplified by retailers' systems over and above that justified by actual demand; and
- problems in operating 'stockless' systems at depots and how widely these arrangements can be applied across different categories and across the retail estate: for example, some supermarkets operate a 'Day 1 ordering for Day 2 delivery to store' system for replenishment of short shelf life products, whereas convenience stores typically operate a 'Day 1 for Day 3 system' and can be stretched to Day 1 for Day 4 at weekends.

3.4 Minimum life on receipt (MLOR)

The point of receipt of the product at a retailer's depot marks a key point in the supply chain at which the remaining life of the product is monitored. This represents the interface between the producer or manufacturer and the retailer and hence is considered a control point where service level agreements are set and measured.

We have found that there are three potential ways this can be flexed to increase the available life for consumers, namely;

- retailers can accept products at depot that have a short shelf life which is below the industry norm for that product ('short-dated stock'), but there is a difficult balance here because it may conceal underlying performance problems in the supply chain or it could result in an increase in waste in stores and in households, the alternative is rejection at depot which could also give rise to supply chain waste;
- retailers can set higher levels of MLOR across their whole range and work with manufacturers to achieve these levels thereby providing more of the product life to consumers; and

- similar products can have different MLORs because they are supplied by different manufacturers or because the delivery performance of a particular manufacturer changes; retailers can work to bring the worst in line with the best.

We looked further at this benchmark and found that variation in MLOR by retail channel was also particularly significant.

3.4.1 Supermarkets

Retailers generally expect that 75% of the total life will be available to them when a product is delivered to depot. Retailers report that 75% is certainly the minimum expectation for long-life products, that is product with a total life greater than 7 days, and that they are pushing for 85% on these products and more widely across their ranges.

However, for the short shelf life products there are daily 'local' negotiations with their suppliers (just as there could be with short-dated stocks). Ideally, for a very short-life product (for example, sandwiches), the retailer would prefer manufacturers to do small production runs on a daily basis, but this may not be profitable for manufacturers and thus the retailer might compromise with a production run every other day. Typically, as a result of these 'local' negotiations, head office will manually enter on the system an agreed life for each product every day.

Table 5 shows a random sample of MLOR actual performance provided by three manufacturers as part of our interview programme. The MLOR actual performance varies significantly in all product categories with all minimums below 60% and all maximums above 75%. This demonstrates the importance of benchmarking MLOR performance and ensuring that improvements are realised by those manufacturers/products in line with the best. Service levels continue to be an important performance measure used widely in the supply chain.

Table 5: MLOR performance

Product category	Sample size (number of products)	MLOR (% actual)		
		Min	Max	Range
Prepared – bag salads	18	43	100	57
Apples	30	50	89	39
Potatoes	8	45	80	35
Chicken breast	11	44	82	38
Juices	21	50	93	43
Milk	16	58	91	33
Ham	31	17	78	61

It does not follow that all of the available life from the depot will be passed on to consumers because it depends on how well the logistics are managed between depot and store and the performance of the 'last 50 yards' between back of store and shelf. According to IGD[17] some 93% of stock is supplied via centralised distribution through a retail warehouse rather than direct from suppliers to stores, and the average levels of depot inventory are reducing. Retailers are shortening order times and moving to 'stockless' depots; both factors have the potential to provide more of the available life to consumers.

[17] *http://www.igd.com/our-expertise/Supply-chain/Logistics/3457/UK-Food--Grocery-Retail-Logistics-Overview/*

Store processes pose a different set of issues including accurate stock records, handling, ease of identification[18] and accurate date code checking on shelf in respect of re-stocking as well as mark-down policies. These issues were outside the scope of this study but it is acknowledged that the 'last 50 yards' could include barriers to providing more available life to consumers.

3.4.2 Convenience stores

Convenience stores (symbol groups and independents) typically work on an average 66% MLOR agreement with suppliers; this is less than the usual 75% (or more) which the multiple retailers demand. This arises because symbol groups and independents in particular purchase smaller volumes from manufacturers - especially of own brand products - and thus have less negotiating power.

Table 6 shows a data set we obtained from the interview programme on the product-specific nature of the MLOR targets. It is not known whether the convenience sector is willing to accept products that have a lower total life than the norm for that product (that is 'short-dated stock') although there is some evidence to support this view. If so, this will diminish the available life for consumers regardless of the MLOR performance.

Overall it appears that consumers will get a shorter time to use a product bought at a convenience store compared with a similar product shopped at a supermarket. This may be acceptable given the nature of 'convenience shopping'; however little is known about household behaviour in terms of how they use these products and their waste profiles.

It can be seen that bread has the highest MLOR (86%) and this may be because suppliers produce the bread in smaller batches and deliver it daily to the depot. Chicken breasts and lasagne have the lowest MLORs, which may be due to the supply chain performance of the respective manufacturers.

Table 6: MLOR Convenience stores

Product	Total life (days)	MLOR - Available life required at depot		Remaining life at store (i.e. shelf-life)	
		(days)	% of total life	(days)	% of total life
Orange juice (long life)	40	26	65	25	63
Orange juice (fresh squeezed)	18	13	72	12	67
Standard milk	13	10	77	9	69
Potatoes	10	6-7	60-70	5-6	50-60
Sliced packed ham	19-20	13-14	65-74	12-13	60-68
Yoghurt	19-20	13-14	65-74	12-13	60-68
Chilled pizza – 'fresh fresh'	7	5	71	4	57
Chilled pizza – longer-life	20	14	70	13	65
Chilled chicken Kiev	10	7	70	6	60
Bagged salads	9	6	67	5	56
Chicken breasts	10	6	60	5	50
Apples	12	8	75	7	58
Chilled lasagne – fresh	10	6-7	60-70	5-6	50-60
Chilled lasagne – longer-life	28	19	68	18	64
Sliced pre-packed bread	7	6	86	5	71

Rejection rates for MLOR infringement at a depot supplying convenience stores was reported to be around 1-2% only and is across the board that is no particular product gets rejected

[18] *http://www.igd.com/Documents/Best%20Practice%20Guides/Supply%20chain/Easy%20ID%20Guidelines.pdf*

more than any other. Rejection rates do increase over the Christmas period with MLOR infringements climbing to 2-3%. This is due to the added difficulty of demand forecasting.

The move of the multiples into the convenience market has resulted in the growth in the short shelf-life, fresh produce within the channel. The multiples are using the same MLOR and OSA performance targets across the two retail channels and hence the conventional convenience stores have to improve their product offerings and systems in order to compete against the multiples.

From a supply chain perspective, the move by the multiples into the convenience market represents a major challenge since they are demanding smaller case sizes and smaller orders whilst maintaining MLOR performance targets.

3.4.3 Online retail

Unlike the conventional retail channels, many of the online retailers provide consumers with a minimum available life guarantee that is 'guaranteed life'. This can help consumers to plan meals and minimise waste. This represents part of the evolution of the online service since, in its infancy, consumers complained that they were receiving many products with minimal available life and they were unable to use all the products in time or plan meals in advance of receiving the order. For further details see the case study on OCADO which is published with this report.

Although the business drivers are different, supermarkets may soon be able to provide a similar service to their customers. They are investigating ways of capturing information on available life and stock availability through the bar code system, with the key driver being the better management of stock. The case study on GS1 also published with this report explains how this could work in practice.

3.5 Date code type

Table 7 shows a summary of the survey results by date code type. This shows that there is no one product category where only one date code type is used. WRAP recommends that all 'display until' codes should be removed on all products. 'Display until' dates are still being used mainly in combination with either 'best before' dates for bread and potatoes or 'use-by' dates for all other products except for yoghurt for which no 'display until' dates were found during the survey. WRAP research[19] shows that, when a 'display until' date is visible, the proportion of people incorrectly interpreting 'use by' as a quality indicator rose from 25% to 32% and the proportion interpreting 'best before' as a safety date increased from 14% to 20%. Additionally, retailers stressed during the interviews for this study that the display until dates, particularly on fresh produce, can result in the need to dispose of 'perfectly good looking' products.

Table 7 shows that 'display until' codes were found on 10 of the 11 product categories surveyed. However, for many products (such as chicken breast, pizza and chicken kiev) only a small number of occurrences were recorded and these were on specific brands or within individual retailers. This demonstrates that the industry has made significant progress by reducing its use of 'display until' (and previously 'sell by') date labels since earlier surveys of this kind. Potatoes, juice, milk and sliced ham are the products with the most opportunity for further improvement out of the products included in this study.

[19] *http://www.wrap.org.uk/sites/files/wrap/Info%20Sheet%20Date%20Labels%20final.pdf*

Table 7: Date code results

Product category	Date combinations						Total
	No dates	Best before only	Use by only	Display until only	Best before + display until	Use by + display until	
Bread	0	4,405	0	0	106	0	4,511
Potatoes	357	709	0	105	574	7	1,752
Yoghurt	0	629	787	0	0	0	1,416
Juice	0	1,184	1,667	0	0	441	3,292
Milk	0	0	2,960	0	0	496	3,456
Salad	0	0	951	0	0	160	1,111
Sliced ham	0	0	1,541	0	0	551	2,092
Chicken breast	0	0	2,224	0	0	39	2,263
Pizza	0	0	1,492	0	0	78	1,570
Chicken Kiev	0	0	1,089	0	0	56	1,145
Lasagne	0	0	611	0	0	80	691
Total	357	6,927	13,322	105	680	1,908	23,299

Potatoes also have 'no dates', 'display until' dates, 'best before' dates, and both 'best before' and 'display until' dates while yoghurt and juice have 'best before' and 'use by' dates. Both products represent a potential opportunity in terms of standardising the date code type used. However, product formulation and processing can dictate the required date code type to be used and must be considered when attempting to standardise the date code types, in terms of using 'best before' when it is a quality factor and 'use by' when it is a safety factor.

3.5.1 Root causes

The research has demonstrated that MLOR performance varies across retail channels and across products. This suggests that improved service delivery and replenishment have the potential to provide consumers with increased available life.

The most significant causative factors for variation in MLOR were cited within the stakeholder interviews as:

- frequency of delivery to depot linked to transport load efficiencies, order size and journey distances;
- frequency and size of production runs;
- over-ordering due to such factors as demand amplification, resulting in finished stock being held at despatch;
- volatility of demand can result in surplus stock being held in the supply chain;
- level of enforcement of service level agreements;
- limited availability of downstream storage;
- overproduction; and
- inaccurate forecasting.

We are not advocating the deliveries which don't meet the MLOR requirement are rejected. Rather, the steps outlined above are addressed through collaborative working between manufacturers and retailers in order to improve long-term performance.

3.6 Product results

In **Table 8** we have brought together a comprehensive summary showing the hotspots (indicated in red) identifying the most significant product life extension opportunities for each of the products in this study. This summary is embellished with further descriptive material in Annex 2. This analysis provides the basis to confirm that each of the five ways we identified by which product life can be increased are all feasible.

We have looked across each of the five areas of challenge identified above and singled out those opportunities that, in our view can be easily implemented and which are likely to make the most impact in terms of waste prevention. We have done this generically using data from WRAP household waste surveys. Individual retailers could undertake their own assessments using high product waste lines or those products that have short shelf lives, for example 3-12 days.

Figure 3 shows our indicative categorisation of products using the above classification represented visually in an opportunity matrix. The impact has been assessed in terms of household waste prevention while the assessment of implementation is based on both the number of opportunities for extending product life identified (based on an assessment of opportunities such as; the buffers, the range of available life and the labelling – as shown in **Table 8**) as well as professional judgement.

Figure 3: Opportunity matrix

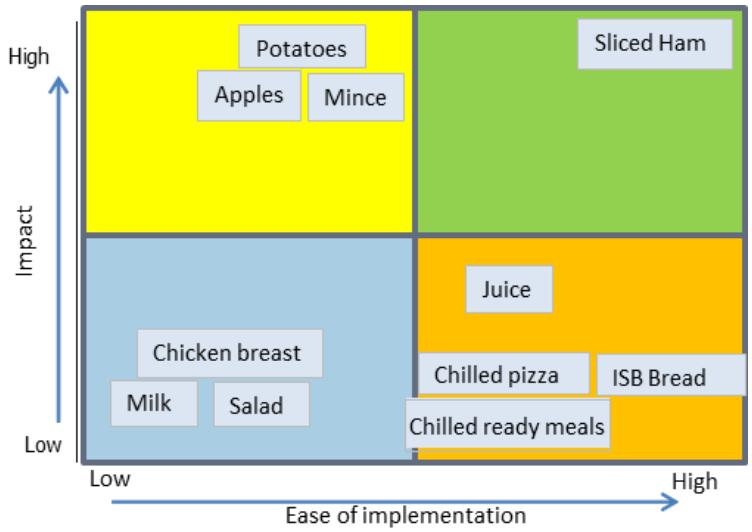


Figure 3 suggests that there are easy to implement opportunities for increasing the product life of sliced ham and that such change could potentially have a high impact in terms of waste prevention (green sector). Other products where there is potentially a high waste prevention impact include potatoes, apples and mince (yellow sector). Changes to product life for those products shown in the blue and orange sectors will have less impact on household waste prevention but still provide opportunities to do so.

There are also generic consistency issues relating to open life guidance which is widespread across many product categories. It was found that such guidance was being applied for both quality and safety reasons and the methodology used to quantify it varied. It was also found that open life and the use of 'buffers' were also set on a presumption that consumer know how and domestic refrigeration control was at a low standard so retailers and manufacturers err on the side of caution.

We are publishing a slide deck alongside this report that works through the opportunities for extending product life for each of the 11 products shown in **Figure 3**. For each product we have identified the main ways to challenge product life received by consumers building on the hotspots analysis in **Table 8** and Annex 2.

Table 8: Hot spot analysis

Product category	Sub-category	Total life (Days)*		Available life (on-shelf) in days		Available life / total life (%)	Open life range (Days)	Use of display until or no dates	Use of use by and best before codes	Limiting factor and buffer (Days)	Potential to extend total life (Ease - impact)	MLOR Range (%)	Impact of date expired losses on OSA (%)	Potential sales uplift (%)
		Mean	Range	Mean	Range									
Bread	Medium sliced white	6.8	6 to 10	2.9	6.8	43	N/A	Yes	No	N/A	N/A	N/A	0.1	0.04 to 0.05
	In store bakery	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Quality (0)	High - Low	N/A	1.3	0.44 to 0.63
Potatoes	Labelled 'white potatoes' or potatoes	10	6 to 12	4.3	10	43	N/A	Yes	No	Quality (0)	Med - High	45 to 80	0.4	0.13 to 0.18
Yoghurt	Strawberry	20	15 to 30	13.7	20	69	N/A	No	Yes	N/A	N/A	N/A	0.6	0.20 to 0.29
Juice	Orange juice with bits	45	12 to 80	35.7	45	79	2 to 5	Yes	Yes	Quality (up to 7)	Med - Med	50 to 93	0	0.01 to 0.02
Milk	Standard semi-skimmed	13	11 to 13	7.9	10.5	61	3	Yes	No	Quality (2-3)	Low - Low	58 to 91	0	0.01 to 0.02
Salad	Bagged labelled 'iceberg'	8.3	7 to 10	3.5	8.3	42	1	Yes	No	Quality (2)	Low - Low	43 to 100	0.8	0.26 to 0.38
Sliced ham	Labelled 'ham' or 'cooked ham'	20	16 to 30	12.2	20	61	2 to 3	Yes	No	Safety (up to 5)	High - High	17 to 78	0.4	0.13 to 0.19
Ready meals	(Beef) Lasagne	25.3	12 to 30	7.6	25.3	30	N/A	Yes	No	Safety (0)	Low - Med	N/A	0.1	0.03 to 0.05
Chicken breasts	Whole skinless breast fillets	10	8 to 10	4.7	10	47	0 to 2	Yes	No	Safety (1)	Low - Low	44 to 82	0.3	0.12 to 0.17
Prepared Food	Chicken Kiev	9.5	8 to 10	4.1	9.5	43	0 to 1	Yes	No	N/A	Low - Med	N/A	0.4	0.14 to 0.20
Prepared Food	Margherita pizza (or cheese & tomato)	10.5	8 to 15	4.5	10.5	43	N/A	Yes	No	Quality (1)	Low - Med	N/A	0.9	0.31 to 0.44
Apples	Pre-packed Granny Smiths	N/A	9 to 15	N/A	N/A	N/A	N/A	N/A	N/A	Quality (0)	Med - High	50 to 89	0.3	0.11 to 0.15
Mince	Beef	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Safety (2)	Med - High	N/A	N/A	N/A

4.0 Quantification of the benefits from increasing available life

This section focuses on three key elements:

- estimating the actual supply chain waste arisings due to date expired losses;
- quantifying the potential economic and environmental savings from increasing available life; and
- estimating the additional potential benefits from increasing available life.

4.1 Estimation of supply chain waste arisings

Table 9 shows that date expired losses have a value in the region of £3-6 billion throughout the retail and manufacturing food and drink supply chain with retail and household being the two most significant contributors. Annex 3 shows the calculations and assumptions used to derive these estimates.

Table 9: Maximum amount of waste arising for date code expiry reasons

Stage	Tonnes (million)	£ billion
Manufacture	0.2	0.19
Retail	0.4	0.5
Household	0.7 - 2.0	2.0 – 5.6
Total	1.3 - 2.6	3.1 – 6.3

4.2 Quantification of savings

This section provides estimates of the potential benefit for consumers and retailers from extending product life by one day. Clearly the impact of this on actual behaviour will depend in part on the actual product life; for example it is likely to be more impactful on products that have between 3-12 days life than say products with 25 – 40 days life.

However, even on short life products, the impact of any increase in product life is unlikely to be cumulative, that is, the waste prevention benefits will continue to improve with continued marginal increases to product life notwithstanding any impacts on product safety and or quality. WRAP is not advocating large scale changes in product life (which are unlikely to be achievable for safety or quality reasons) rather, we believe there is scope, based on this research, for adding one-day to a wide range of products thereby preventing significant amounts of waste. For some products there may be potential to add more than one day because changes could be made to packaging or product formulation.

4.2.1 Impact on consumers

To calculate the impact increasing available life will have on consumers, data from previous WRAP studies were used. Unfortunately, the definitions of product types varied across these studies and hence a 'best fit' approach was required. **Table 10** shows the five resulting categories that are common and the potential savings from increasing the average available life to the consumer by one day across these categories. Annex 3 shows the calculations and assumptions used to derive these estimates.

WRAP's 'Household Food and Drink Waste in the United Kingdom' (2012) study estimates that 4.2 million tonnes at a cost of £12.5 billion of avoidable food waste is generated per year in the UK. Therefore, applying the overall average financial saving from an additional day (£0.46bn) to the total cost of avoidable food waste (£12.5bn) enables us to estimate the

savings in household waste, which amounts to 0.17 million tonnes - by applying the 3.6% overall average financial saving from an additional day, to the sector level estimates.

Table 10: Estimates of household waste prevention from an additional day of product life

Product type	Total waste arising		Estimated savings from increasing available life by 1 day	
	Tonnes	£ millions	Tonnes	£ millions
Bread	560,000	860	14,600-24,800	22.4-38.0
Fresh fruit	910,000	900	36,400-61,900	36.0-61.2
Ready meals	160,000	890	3,200-5,400	17.8-30.3
Fresh veg Salad	1,600,000	1,700	38,400-65,300	40.8-69.4
Total	3,230,000	4,350	92,600-157,400	117.0-198.9

We acknowledge the arbitrary nature of this calculation. It is clear to us that consumer behaviour will be impacted by the product life profiles, that is consumers may have products that range from 1 day to in excess of 50 days in a typical shopping basket. Their behaviour is most likely to be impacted by those products with a short life for example from 3-12 days. Such products are likely to be predominant in a typical shopping basket but obviously there will be huge variations. Further, our aim is not to provide a precise calculation but to demonstrate the principle that small changes in product life can help reduce household waste.

4.2.2 Impact on retailers

The estimates of the potential savings for the retailers are shown in **Table 11**. Annex 3 shows the calculations and assumptions used to derive these estimates.

Overall, a small increase in product life equates to a 20% reduction in the total date expired waste currently being generated. Applying this across the total sector level data where the expired waste accounts for 0.4 million tonnes at a cost of £0.5billion (**Table 10**) gives an estimate that a 1 day extension to shelf life at retail could reduce waste by 80,000 tonnes with a saving of £0.1billion.

Table 11: Estimates of retail waste prevention from an additional day of product life

Product type	Amount purchased by households in 2011 (Tonnes)	Mean date expired losses at retail (% sales)	Estimated date expired losses at retail (Tonnes)	Reduction in date expired losses from extending available life by 1 day	
				(% sales)	(Tonnes)
Standard bread	1,600,000	3.0	48,000	1.0	16,000
Poultry (chicken) / turkey / duck	820,000	4.3	35,260	0.9	7,380
Pre-prepared meals	428,000	5.3	22,684	0.9	3,852
Fruit juice and smoothies	1,100,000	0.4	4,400	0.01	110
Milk	5,100,000	0.5	25,500	0.1	5,100
Potato	1,600,000	1.3	20,800	0.3	4,800
Lettuce and leafy salad	170,000	5.5	9,350	1.6	2,720
Sliced ham	236,000	3.5	8,260	0.3	708

Yoghurt / yoghurt drink	479,000	1.4	6,706	0.1	479
Total	11,533,000	1.5	180,960	0.3	41,149

This amount will be impacted by the effectiveness of mark down policies which are constantly evolving.

4.2.3 Distribution of benefits

This study does not attempt to estimate what proportion of the savings in retail waste would fall to manufacturers and what proportion would fall to retailers. Rather, it is assumed that all the benefit accrues to retailers which in line with our assumption they then pass on in full to consumers. This benefit therefore cannot be realised twice, that is by both retailers and manufacturers, although we can add the retailer savings to the consumer benefit to give a total potential savings in household waste of 0.25 million tonnes, worth £0.47 billion, from a one day extension in shelf life.

4.3 Business case

For a retailer or manufacturer, the business case based on waste prevention alone can be derived either from the supply chain savings or from savings by consumers. The true value of waste in the supply chain[20], estimated to be £950 per tonne at manufacturing and £1300 per tonne at retail includes all the labour, non-labour costs and materials that went into the product and is significantly higher than the disposal cost of waste.

Industry also benefits from the savings made by household when they reduce their food waste because WRAP research has shown that household savings from wasting less food is spent on food because consumers 'trade-up' thereby benefitting the supply chain.

In addition to the benefits from waste prevention (and trading up) retailers and manufacturers also stand to gain through improved on shelf availability leading to increased sales as outlined below.

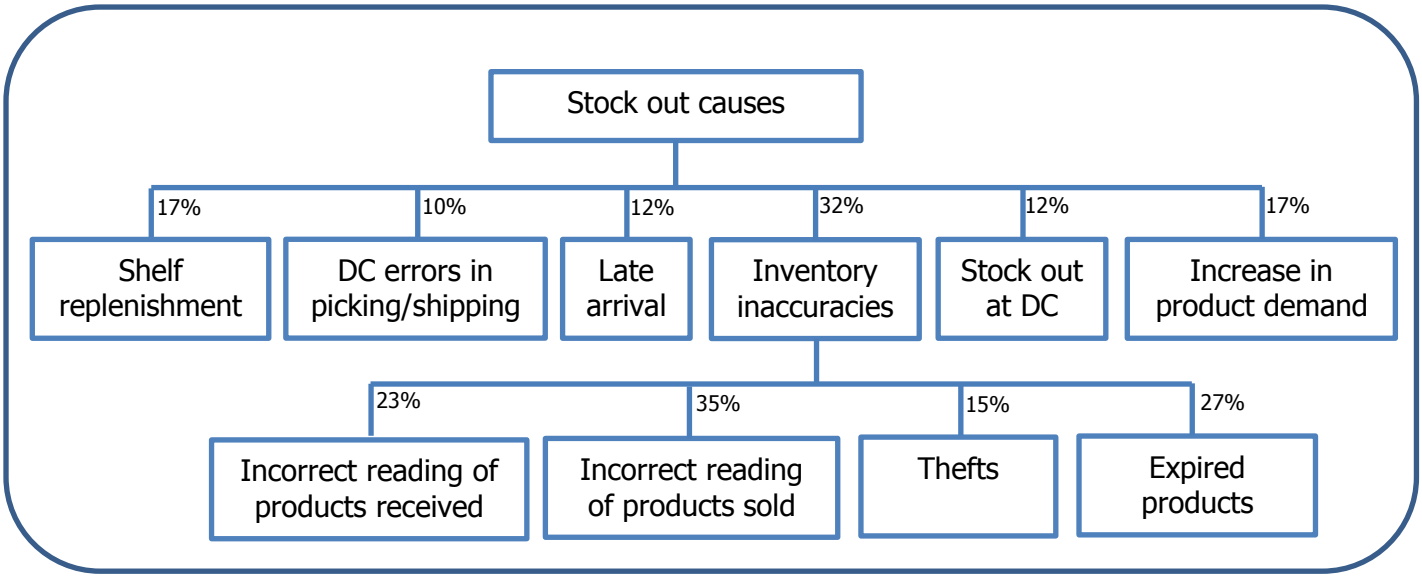
4.3.1 Impact of date expired losses on OSA and sales

Extending product life can lead to increased on-shelf availability. This is demonstrated by our case study reporting the result of the business experiment undertaken as part of this work and by work undertaken through the Efficient Consumer Response (ECR) programmes.

In 2010, the University of Parma[21] estimated that, in Europe, 32% of stock-outs of fast moving consumer goods (FMCG) at retail stores are caused by inaccuracies in inventory, and 27% of these are due to expired products, that is, 8.6% of total stock-outs are due to date-expired products. **Figure 4** shows the relationship between date expired products and on-shelf availability.

[20] http://www.wrap.org.uk/content/estimates-waste-food-and-drink-supply-chain
[21] http://www.supplychain-forum.com/article.cfm?num=23&art=194

Figure 4: On shelf availability and date expired products



Source: University of Parma

Without a UK-specific estimate, the 8.6% figure estimated by the University of Parma and OSA data provided by retailers has been used to identify the impact of date code expiry on OSA. These estimates are shown in **Table 12** for the selected product categories.[22] OSA is always measured as a % with 100 equivalent to a product always being available on shelf (though there are different ways of measuring OSA). Therefore, the data can be interpreted as a 'rank order' with %'s less than 100 representing progressively worse performance. The analysis shows that for some categories where the OSA is already very high (i.e. juice and milk) the impact of extending product life is negligible, whereas for the poorer performing categories (such as in-store baked sliced white bread, margherita pizza and bagged iceberg salad) the impact is significant (equating to between 0.8% and 1.3% points).

Table 12: On shelf availability and date code expiry

Product	Sub category	OSA (%)	Impact of date expired losses on OSA (%)
Bread	Medium sliced white	98.8	0.1
Bread	In store baked sliced white	85.3	1.3
Potatoes	Labelled white potatoes	95.8	0.4
Yoghurt	Strawberry	93.3	0.6
Juice	Orange juice with bits	99.6	0
Milk	2 pint standard semi skimmed	99.6	0
Salad	Bagged iceberg	91.2	0.8
Sliced ham	Labelled cooked ham or ham	95.6	0.4
Ready meals	Serves 2 beef lasagne	98.9	0.1
Chicken breasts	2 piece skinless	96	0.3
Prepared food	2 piece chicken Kiev	95.4	0.4
Prepared food	Margherita pizza	89.7	0.9
Apples	Pre-packed Granny Smiths	96.4	0.3

[22] *The impact is calculated by subtracting the current OSA (%) by 100% and then multiplying this by 8.6%.*

ECR Europe reports that a 1% increase in OSA results in a 0.5% increase in sales.[23] **Table 13** shows the potential sales uplift if the date code expiry losses could be reduced in full using the ECR conversion factors. Although the sales uplift percentages are small, they need to be applied to the sales totals giving a significant result. This demonstrates that it is also in the retailer's interest to obtain the maximum period of time in which to sell products.

Table 13: Potential sales uplift

Product	Sub category	OSA (%)	Impact of date expired losses on OSA (%)	Sales uplift (%)
Bread	Medium sliced white	98.8	0.1	0.05
Bread	In store baked sliced white	85.3	1.3	0.63
Potatoes	Labelled white potatoes	95.8	0.4	0.18
Yoghurt	Strawberry	93.3	0.6	0.29
Juice	Orange juice with bits	99.6	0	0.02
Milk	2 pint standard semi skimmed	99.6	0	0.02
Salad	Bagged iceberg	91.2	0.8	0.38
Sliced ham	Labelled cooked ham or ham	95.6	0.4	0.19
Ready meals	Serves 2 beef lasagne	98.9	0.1	0.05
Chicken breasts	2 piece skinless	96	0.3	0.17
Prepared food	2 piece chicken Kiev	95.4	0.4	0.2
Prepared food	Margherita pizza	89.7	0.9	0.44
Apples	Pre-packed Granny Smiths	96.4	0.3	0.15

There are of course many other opportunities for extending product life: for example, an interviewee told us that skin packs on fresh red meat can double the life in stores (for example from 5 to 10 days) and cut waste from around 6% to 2%. Reduced waste provides stores with the confidence to order more packs which in turn can lead to increased sales.

[23] *Improving on-shelf availability: It matters more. Symphony IRI Group 2012.*

5.0 Conclusions

Expiry of product life causes food to be wasted in the home and in supply chains. We have estimated that up to 2.6mt of food with a value of £6.3bn could be wasted annually because products are not used in time.

This research has demonstrated that there are potentially multiple opportunities to provide consumers with increased product life without any changes to product formulation or packaging ('design changes'). Even a one-day extension to product life could potentially save 0.25mt of food waste and be done without 'design' changes, and without compromising consumers' perceptions around 'freshness'. The five potential ways of challenging product life identified in Section 1 all proved to be feasible leading us to believe that such a one day increase in product life would not compromise food safety or quality. Further, such a small increase would help retailers and manufacturers by improving on-shelf availability and sales.

The benefits from increasing product life will be more significant for products that already have a short life, for example between 3-12 days or for products that have high rates of waste in the home or in the supply chain (for some products these criteria may coincide). We examined in detail some 10 everyday food products and for all we found that in either supply chain operations or in the technical assessment of products there are ways to provide more product life to consumers.

The research has demonstrated a clear business case for action. This is based on savings that arise from waste prevention and increased sales that result from improved on-shelf availability. We acknowledge that there are regulatory and other pressures that could lead to reductions in product life (for example, voluntary agreements on reductions in salt or restrictions on the use of certain crop protection products) and that retailers and manufactures have already made some beneficial changes. WRAP will continue to press for different forms of packaging, for example skin packs or light exclusion packs that can extend product life. But this research has shown that there are clear low-cost opportunities to make a one day increase in product life that is both commercially and environmentally beneficial. We therefore recommend the following:

- Retailers for own label and manufacturers of brands should review the 'total life' of all products with a focus on short shelf life or high waste products with a view to challenging the 'buffers' that are in place in order to find opportunities to compress these;
- There should be a consistent approach across both own label and brands on setting open life for comparable products;
- Retailers and manufacturers should challenge current 'open life' guidance that is on pack, in terms of length (that is number of days) and also whether it is needed at all from a food safety point of view;
- Practice shows that an 85% minimum life on receipt at retailers' depots is achievable and this standard should therefore be rolled out more widely in order to provide consumers with more of the product life;
- Retailers' protocols for stock rotation, which can lead to large date ranges on shelves, and mark down policy, which could prevent food waste, should be reviewed in light of this research;
- Manufacturers should examine ways of reducing processing times through the use of lean manufacturing principles to investigate the potential for giving consumers increased available life; for protein products improved process hygiene will also play a key role; and
- All 'display until' dates should be removed from packs leaving only use-by and best before dates and open life guidance; further, use-by dates should be confined to products where

there is a safety risk and there should be better storage advice on pack and in-store provided to consumers.

In the longer term and involving greater cost, we recommend that trials take place in the UK to test out the efficacy of new bar code systems that can record product life, and that new technologies like thermo-chromic inks are used to help consumers store products at the correct temperatures.

Retailers and manufacturers can start this review process by benchmarking their own product life performance. WRAP would be pleased to facilitate such discussions using unpublished data from this study. We will establish a cross industry working group to encourage and facilitate a consistent approach to product life and open life setting to take forward the recommendations in this research.

WRAP will also continue to monitor and report on date code labels, on pack guidance and open life guidance through the forthcoming Retailer Survey in 2015.

Annex 1: Detailed description of the baseline survey product categories

Product category	Sub-category	Pack size	Pack format	Storage
Bread	Medium sliced white	800 g	Plastic or wax paper bag only	Ambient
Potatoes	Labelled 'white potatoes' or 'potatoes'	2.5 kg	Film bag only	Ambient
Yoghurt	Strawberry	150 g	Plastic pot only	Chilled
Juice	Orange juice with bits	1000 ml	Tetrapak OR plastic bottle	Chilled
Milk	Standard semi-skimmed	2 pints	Plastic bottle only	Chilled
Salad	Bagged labelled 'iceberg'	200 g	Sealed plastic bag only	Chilled
Sliced ham	Labelled 'ham' or 'cooked ham'	125 g	Plastic tray with film lid only	Chilled
Ready meals	(Beef) Lasagne	Serves 2	Plastic/foil tray with film lid only. Might be in cardboard box/sleeve or not	Chilled
Chicken breasts	Whole skinless breast fillets	2 pieces	Plastic tray with film lid only	Chilled
Prepared Food	Chicken Kiev or Margherita pizza (or cheese & tomato)	2 pieces or 1 single item pack	Plastic/foil tray with film lid only, Might be in cardboard box/sleeve or not Plastic wrapped or cardboard box	Chilled
Apples/Mince*	Produce/Beef	Bagged/250g	Film bag/MAP	Ambient/Chilled

* Part analysis only

NB: All products are a mix of own label and brand apart from in-store baked bread which is entirely own label

Annex 2: Analysis of the opportunities for extending total life.

Product	Sub Category	Limiting factor	Total life (days)[24]	Open life (days)	Buffer (Days)	Buffer (%)[25]	Retail and trade association input	Barriers	Opportunities
Bread	In store baked sliced white	Quality	2	1	nil	0	Shelf life behaviour is led by retailers	Customer proposition is freshness. Longer life alternatives are available.	Products still carry display and use by dates which may confuse customers. These are in place to help in store bakery managers control stock. Customer behaviour shift to manage 'end of life bread'
Potatoes	Labelled white potatoes	Quality	6	storage instructi on - cool dark place	nil	0	Shelf life behaviour is led by retailers	Products are photosensitive and start to deteriorate once washed. Products are stored chilled for many months and start to respire once warming process starts	Theoretically, potatoes can last for much longer than currently indicated if stored chilled and in paper bags - which omit light and are less sweaty and less prone to bacterial breakdown. Smaller bags would also be beneficial as it may encourage refrigeration.
Mince	Beef	Safety	7-9	1	2	18-22	Shelf life behaviour is led by retailers, and it was noted that there is inconsistency between retailer approaches which leads to differences in life between similar products. There is particular concern regarding domestic fridge temperatures. This has a direct impact on safety and product life.	Elevated temperatures have significant and rapid impact on product deterioration.	Skin packing is useful as it removes oxygen which slows discolouration. The greatest opportunities to extend life will come through reducing microbial load at carcass level this could achieve a consistent 9-10 days life. Better control of retail and domestic fridges <4Deg C will have beneficial impact on product life.
Juice	chilled Orange juice with bits - pasteurised	Mainly quality	21-30	2 days for smaller units, up to 4 for larger	dependent on specific processing	7-16	Shelf life behaviour is led by retailers.	Process hygiene is very much the limiting factor.	It was suggested that in some cases 'open life' could be extended by up to 50%
Juice	chilled Orange juice	Mainly quality	7-14	2	up to 7 days in	33-50	Shelf life behaviour is led by retailers.	Process hygiene is very much the limiting factor.	Improvements in hygiene and processing have opened up the opportunity to extend

[24] A small number of products in the samples, particularly for juice and a smaller number for other products, such as lasagne, are longer life products and this explains some of the larger ranges in product life in Tables 2 and 4 and in this Annex.

[25] This is a % of Total life using Julian Codes. It is useful to express as a % because it shows the degree of significance of even one day, product life on a shorter shelf life product.

Product	Sub Category	Limiting factor	Total life (days)[24]	Open life (days)	Buffer (Days)	Buffer (%)[25]	Retail and trade association input	Barriers	Opportunities
	with bits				some cases			In addition customer proposition is freshness. Longer life alternatives are available.	the life of a number of fresh juice products. Recent trials by a manufacturer have seen lives of some products extended to up to 14 days
Milk	2 pint standard semi skimmed	Quality	12-14	3 days	2-3	13-20	Shelf life behaviour is led by retailers. There is particular concern regarding domestic fridge temperatures. This has a direct impact on safety and product life.	Process hygiene is very much the limiting factor. In addition customer proposition is freshness. Beyond 16 days would never be implemented as product quality cannot be assured after that point. Longer life alternatives are available.	Elevated temperatures have significant and rapid impact on product deterioration. Better control of retail and domestic fridges <4Deg C will have beneficial impact on product life.
Salad	Bagged iceberg	Quality	4-8	1	2	20-33	Shelf life behaviour is led by retailers. There is particular concern regarding domestic fridge temperatures. This has a direct impact on quality and product life.	Products are photosensitive and start to deteriorate once washed. Products are stored chilled for many months and start to respire once warming processed starts	Benefits would be gained by maintaining better temperature control once it had left the control of the processor. For example use of closed refrigeration in store and better consumer behaviour.
Sliced ham	Labelled cooked ham or ham	Safety	21-25	2	up to 5 days in some cases	17-19	Shelf life behaviour is led by retailers, and it was noted that there is inconsistency between retailer approaches which leads to differences in life between similar products. There is particular concern regarding domestic fridge temperatures. This has a direct impact on safety and product life.	Process hygiene is very much the limiting factor as slicing is the step that introduces the contamination that accelerates the degradation. Process and supply chain temperature control including domestic storage. Elevated temperatures have significant and rapid impact on product deterioration	In the case of sliced ham there is a total shelf life that includes the 'pre-slicing' life. This is set at 15 days and little work is done on extending this. Once sliced up 25 days is applied depending on product. It was suggested that the '15 day pre-slice' could be easily challenged. Better control of retail and domestic fridges <4Deg C will have beneficial impact on product life. Deep chill <2 deg C transport is under consideration

Product	Sub Category	Limiting factor	Total life (days)[24]	Open life (days)	Buffer (Days)	Buffer (%)[25]	Retail and trade association input	Barriers	Opportunities
Ready meals	Serves 2 beef lasagne	Safety	8	1	nil	Not known	Shelf life behaviour is led by retailers. There is particular concern regarding domestic fridge temperatures. This has a direct impact on safety and product life.	Elevated temperatures have significant and rapid impact on product deterioration. Customer proposition is freshness. Longer life alternatives are available. Elevated consumer complaints through extending life.	Better control of retail and domestic fridges <4Deg C will have beneficial impact on product life. Gas flushing and Modified Atmosphere Packaging (MAP) are available but are not used as it compromises the perception of freshness. It is increasingly important to consider pack format and size and tailor them to store format. This will ensure that ordering is 'smart'. Improved ordering systems that considered the life of products on shelf would also help rotation and stock management.
Chicken breasts	2 piece skinless	Safety	10	1	1	9	Shelf life behaviour is led by retailers, and it was noted that there is inconsistency between retailer approaches which leads to differences in life between similar products. There is particular concern regarding domestic fridge temperatures. This has a direct impact on safety and product life.	Complaints were reported to increase 5 fold with every day of life over 9 days. Elevated temperatures have significant and rapid impact on product deterioration	Better control of retail and domestic fridges <4Deg C will have beneficial impact on product life
Prepared food	Margherita pizza	Quality primarily	6-8	0	1	11-14	Shelf life behaviour is led by retailers, and it was noted that there is inconsistency between retailer approaches which leads to differences in life between similar products. There is particular concern regarding domestic fridge temperatures. This has a direct impact on safety and product life.	Customer proposition is freshness. Certain products are limited by the 10 days rule due to their meat content. However since the product is fresh other components will deteriorate before this is exceed	There may be potential to consider gas flushing but products re multi component so specific nature of gas flushing may not be suitable
Apples	Pre-packed Granny Smith	Quality	5	n/a - - storage advice	nil	0	Shelf life behaviour is led by retailers, and it was noted that there is inconsistency between retailer approaches which leads to differences in life between similar products.	Shelf life of product is dictated by variety and harvest. Primary issue is 'in home practice' where advice is ignored (fruit bowl)	Refrigeration stops product aging. Lower temperature storage - in retail and in home. Packaging may present opportunities (MAP) but less significant than storage

Annex 3: Estimated benefit from increasing shelf life.

This Annex details the calculations and assumptions made in quantifying the benefits of a marginal increase in shelf life.

Waste Arising
We have robust estimates of the amount of waste arising in the supply chain but it is not always possible to attribute an assignable cause as to why this quantity of waste has arisen, for example, out of 'use by' or 'best before' date. In this first section we document how the estimates of waste due to date code expiry have been derived.

Manufacture
Food and drink waste in manufacturing is estimated to amount to 3.9 million tonnes in 2011 with an estimated value of £3.7 billion.[26]

We have no estimate of the quantity of waste caused by out of date product life. There are a number of potential reasons why waste (and also loss) could arise from products reaching their date code:

- Demand volatility in short shelf life products, such as salads, can have a significant impact up the supply chain. Products are often produced to forecast because the precise order is not known until late. If the order is lower than expected then 'overproduced' product could be reworked and re-sold with product life limiting the time available for this to happen thereby risking increased waste;
- Some orders may get cancelled at the last minute, for example in the export market and need to be reworked for a new market or wasted;
- Some promotions may not perform as well as expected and if the products cannot be sold they may enter the waste stream;
- New product launches could fail for example because consumers are unfamiliar with the offer so the product enters the waste stream; and
- Products can be rejected by customers at their depots for example because of incorrect labelling thereby providing a manufacturer with an opportunity to re-work the product – if additional time could be added to product life there would be potential to re-sell the product in a prime market.

From the previous work undertaken through WRAP Waste Prevention Reviews (WPRs) and the sector interviews for this study, it is estimated that a maximum of 5% of waste in manufacturing is caused by product life expiration. Based on the aforementioned total waste estimates this equates to 0.2 million tonnes with a value of £185 million per annum.

Manufacturers are under pressure to move product through the supply chain more quickly and therefore it is likely that any increase in product life would be passed directly to retailers. However, lean production systems provide manufacturers with the ability to strip out time and costs from their operations by reducing non-value adding activity, potentially speeding up their own processes. In this respect 5% is an underestimate of the potential benefits that could accrue from materials input to the point at which product life is actually given in the production process.

[26] *http://www.wrap.org.uk/sites/files/wrap/Waste%20arisings%20in%20the%20supply%20of%20food%20and%20drink%20to UK%20households%2C%20Nov%202011.pdf*

Retail
We have estimated that 0.43 million tonnes of food and drink was wasted by retail in 2011[27]. This includes waste arising in stores and at depots. Data provided by three major retailers for this study shows that 94.8% of the food waste generated by retailers is due to date expired losses and 5.2% is due to quality losses. The ratio of 'date expired' to 'quality losses' is product category specific with a high bias towards date expired losses in the short shelf life categories (for example, bakery, salads, vegetables) and a strong bias towards quality losses in the frozen and the beers, wines and spirits product categories. Therefore the overall ratio of date expired to quality losses is heavily dependent on the product mix offered by the retailers. Although we have used the 94.8% figure in the calculations it maybe a overestimate, but our discussions with retailers confirm that product life expiry is a major cause of retail waste.

Using the 94.8% date expired losses figure, it is estimated that 0.4 million tonnes is generated due to date expired losses. From an economic perspective, it is estimated that the 0.4 million tonnes with a value of £0.5bn each year is being lost by retailers.

Since this research was completed we now have revised and lower estimates of retail food waste compared with those we published for 2011. However, we believe the manufacturing food waste figure is an underestimate because it disregards the potential advantages of fully exploiting lean production systems. Given that the levels of manufacturing food waste are significantly higher than those of retail food waste, on balance the total amount of food waste lost because of product life expiry in the supply chain is probably an under estimate. Because there is a greater reliance on professional judgement we have not put any ranges on the numbers. Waste arising in the retail supply chain for product life reasons is significant but substantially less than in households.

Households
We have estimated over 2 million tonnes of food and drink is wasted by UK households due to 'not used in time'[28]. From an economic perspective, it is estimated that the 2 million tonnes wasted in the household costs £5.6bn. We have looked into the reasons for disposal given by households. Date labels were cited in 33% of occasions (0.66 million tonnes) and 'gone off' or similar in the remaining cases. About half of the 2 million tonnes was whole / unopened when it was disposed and the rest was part used/in open packs.

Our view is that 0.66 million tonnes, which we have rounded to 700,000 tonnes is a lower bound on the amount of waste that can be directly attributed to date label expiry while 2 million tonnes is an upper bound. While we cannot be wholly certain, it is likely that a proportion of those reporting 'gone off' or similar as their reason for disposal, will have done so with some reference to the date label.

Table 14 shows that date expired losses have a value in the region of £3-6 billion throughout the retail - food and drink supply chain.

[27] http://www.wrap.org.uk/content/estimates-waste-food-and-drink-supply-chain
More recent analysis by WRAP suggests that retail waste could be lower than these published estimates for 2011.
[28] http://www.wrap.org.uk/content/household-food-and-drink-waste-uk-2012.

Table 14: Maximum amount of waste arising for date code expiry reasons

Stage	Tonnes (millions)	£ billions
Manufacture	0.2	0.19
Retail	0.4	0.5
Household	0.7 - 2.0	2.0 – 5.6
Total	1.3 - 2.6	3.1 – 6.3

Quantification of benefit of extending product life

This section provides estimates of the potential benefit for consumers and retailers from extending product life by an incremental amount.

In practice, a typical shopping basket will contain a range of products of varying product life. Some products may have short product lives while others could have a considerable time before they become unsafe to eat or the quality deteriorates. It is very unlikely that consumers would benefit by reducing their waste to the same extent from an increase in product life for a short dated product compared to one that has a much longer date. Using discrete event simulation, we have modelled the impact of increasing available life on milk consumption in households[29]. This work demonstrates that a small increase in shelf life could lead to a considerable reduction in waste. We also have reasonable estimates of the amount of food that is wasted by households for date label reasons though we don't know how consumers would behave when given an additional day of life: for example would all or some of the product be consumed if additional time was available before a use-by or best before date became due.

At retail, there will clearly be products with varying degrees of life on shelf at any one time overall or within a category. There is evidence to suggest[30] that there is an inverse relationship between product life and waste such that the shorter the product life the greater the quantity of waste. This arises because of the shorter time scale for sales and also because of demand volatility caused by weather and other reasons unrelated to product life. Our discussions with retailers have confirmed this relationship. WRAP has also conducted a business experiment with a major retailer and manufacturer in which product life was artificially changed and its impact on waste (sales and on-shelf availability) monitored. This has enabled us to demonstrate, in practice, a direct link between waste prevention and small increases in product life. It also has enabled us to estimate how waste reduces with small increases in product life, albeit only for the products for which the date code has been artificially changed in the experiment.

It is an over-riding principle of this research that we are aiming to encourage the supply chain to make an incremental change in the extension of the life that is available to consumers without compromising safety or quality criteria. This could of course be in the form of a small increase to product life or that more of the product life is provided to consumers. We do not expect that the impact of small incremental steps to be cumulative for any given product (unless they are accompanied by significant 'design' changes) and this is not what we are advocating.

The basis for our calculation is a 1 day increase in product life that is passed on in full by the supply chain to the consumer. We accept that a 1 day increase will be significant for a short dated product and insignificant for a long dated product in terms of its potential impact on

[29] *http://www.wrap.org.uk/sites/files/wrap/Milk%20Model%20report.pdf*
[30] *Evidence on the role of supplier-retailer trading relationships and practices in waste generation in the food chain, 2009, Cranfield University*

behaviours. This means that an extrapolation of the results from the sample of products that have been the focus of this study (see Annex 1) to the overall grocery market (which will have a different and wider mix of products) has to make the assumption that the whole market will behave in the same way. The assumption that all the benefit of an additional day is passed to consumers is more robust.

Consumer Benefit

We have drawn on a detailed study conducted by Brook Lyndhurst[31] because it includes a survey of the behaviour of consumers with respect to date codes and their disposal routines. This is the only such study that we are aware of to examine these issues in detail. While the results from this report are based on relatively small samples it provides the best source of data for the task in hand. The other difficulty relates to the consistency of product groups across various studies though there was a good deal of overlap with the Brook Lyndhurst work including bakery, ready meals, meat, salads and fruit for example.

Figure 5 maps when food items are thrown away in relation to their date code for all items in the Brook Lyndhurst dataset. This shows a peak in food items with both 'use by' and 'best before' dates being thrown away one day after the date on the label. It also shows a very broad range and this is due to the wide range of different reasons for throwing away the food items. The chart also shows that the disposal profiles for use by and best before are broadly similar though use-by dates appear to provide a stronger reason for disposal. Unfortunately it is not possible to associate quantities of food that are wasted with each disposal date.

Figure 5: Food disposals in relation to date codes

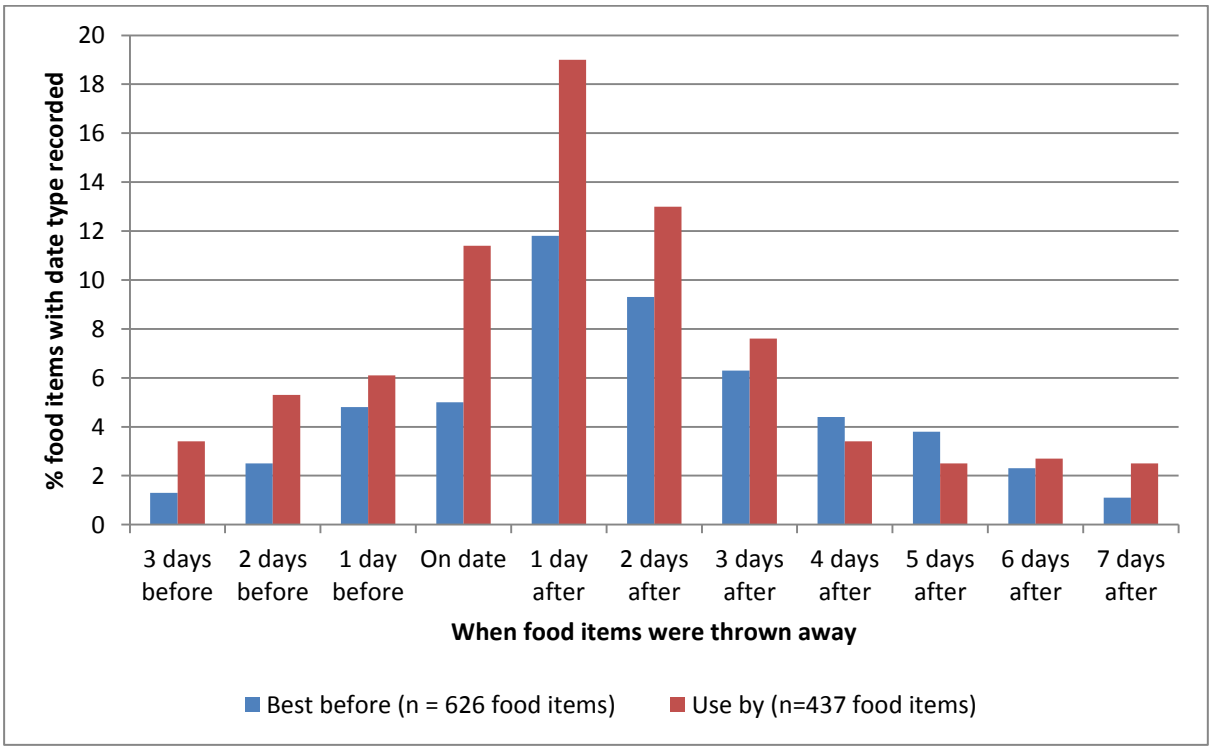
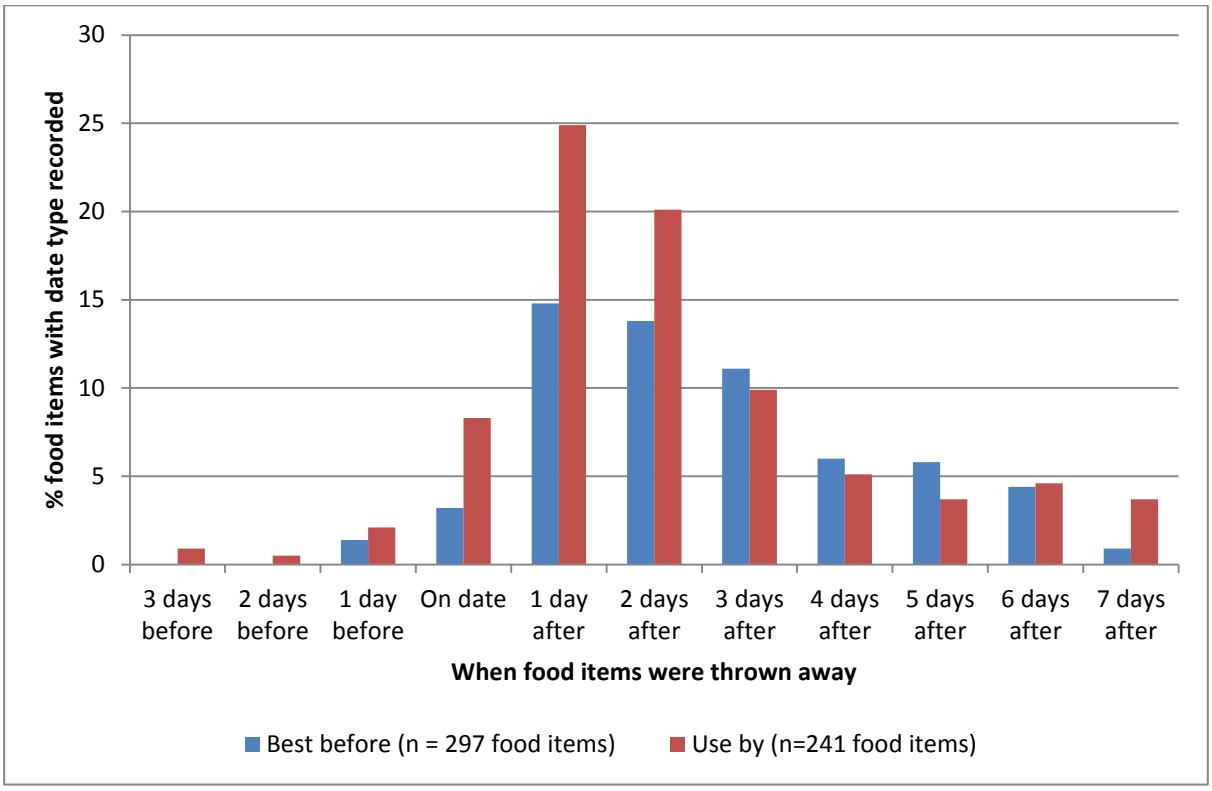


Figure 6 shows the results of the survey where 'after the date on the label' was rated important as a reason for food to be thrown away. Again, these data show frequency of disposal rather than the actual quantities that are being disposed. When compared against

[31] http://www.wrap.org.uk/sites/files/wrap/Technical%20report%20dates.pdf

Figure 5 this shows that very little food thrown away prior to the date on the label that can be attributed to the date label. The data profile is more skewed compared to **Figure 5** with the majority of disposals within 1 to 3 days of the use by and best before dates. The data also clearly show that many consumers do not throw products away until well after their product life has expired including where safety is the limiting factor.

Figure 6: Food disposals after date code expiry



To make an estimate of the waste prevention benefit of an additional day of product life we have assumed:

- increasing product life by one day would impact most on the food being thrown away within one day of the current mean disposal date;
- that no additional consumption would arise in the extra day, in other words the amount of food wasted continues to be the same after the extra day, so no food waste is avoided;
- the reduction in food waste is equal to the proportion of disposal volumes one day after the mean;
- all the disposal is due to product life reasons only;
- the samples, although small, are representative and can be extrapolated to the entire UK grocery sector; and
- consumers' respond in the same way to all products regardless of existing length of product life.

We acknowledge that these assumptions can be challenged, but the behavioural data on milk does support this approach as does the results from our business experiment, so providing a basis on which a waste prevention benefit calculation can be determined. In particular, we acknowledge the assumption that there is no avoidance of food waste from the additional day provided for consumption as contrary to the objectives of this work. It

would of course be possible to arbitrarily reduce the amount of waste but we have no evidence on what such a proportion might be.

Figure 7 illustrates the process behind our calculations for bread where the mean disposal date is 1.9 days after the date on the label. Assuming that the profile of the waste arising is the same as disposals and can be approximated by a normal distribution, the potential savings from increasing the product life by one day refers to the area under the curve between the mean disposal date and one day after this date. Because we only have disposal events not disposal quantities we have to assume that each occurrence of food being thrown away is uniform in terms of quantity.

Figure 7 Disposal of bread

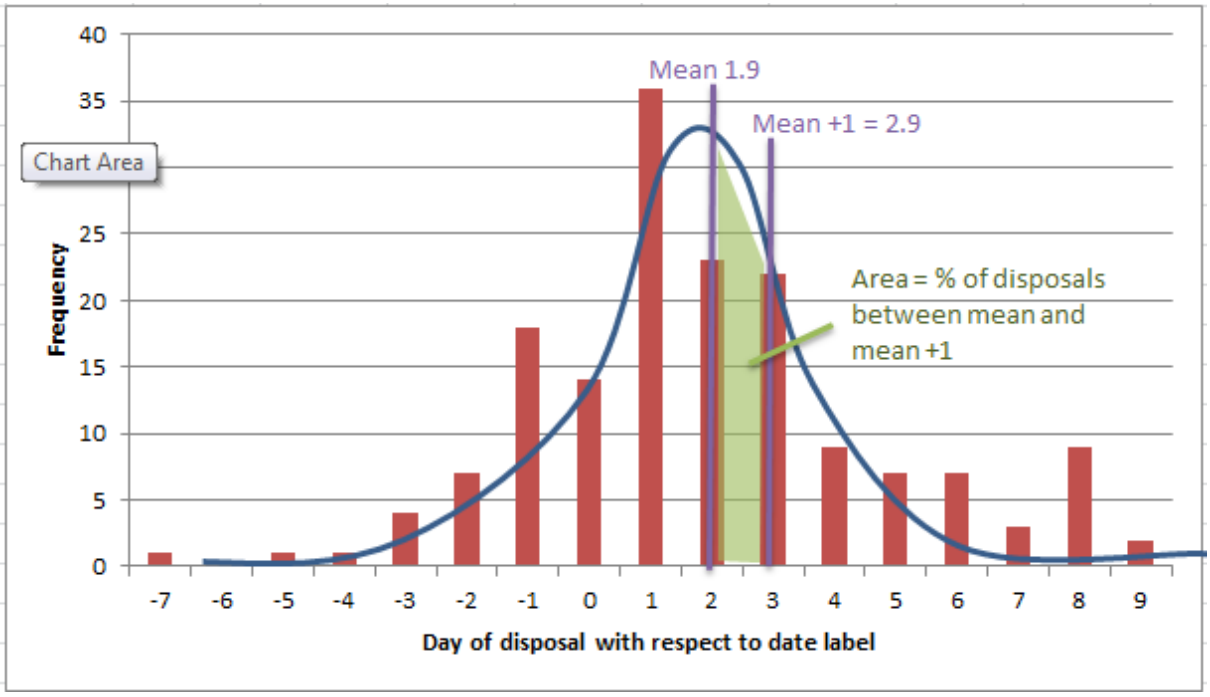


Table 15 shows the results from the six product categories studied by Brook Lyndhurst. This shows that on average most of the products are disposed of between 1 and 3 days after the date code with the exception of cooked meat which, on average, is disposed of 0.2 days before its date code. This is likely to be due to the date label on the cooked meat being a 'use by' date and consumers being more sensitive to food safety issues.

Table 15: Comparison of disposal day and date code

Product type	Sample Size (n)	Day of disposal with respect to date label	
		Mean	Standard deviation
Bread	164	1.9	2.9
Fresh fruit	43	1.8	1.9
Cooked meat	49	-0.2	3.8
Ready meals	12	0.8	3.8
Fresh veg	84	3.1	3.6
Salad	30	2.1	2.9

The mean and standard deviation were used to calculate the shaded area under the curve shown in **Figure 7** to provide the estimate of the percentage reduction in waste from increasing available life by one day, using standard statistical tools. **Table 16** shows the results of the analysis. We have used the formula for a standard normal distribution.
The '% reduction in waste' is calculated by subtracting the 'conversion of u using statistical tables' by 0.5, i.e. to determine the area under the curve. This is then multiplied by 100 to convert it to a percentage.

Table 16: Waste disposal calculation

Product type	Available life (on-Shelf) in days		$u = \frac{x - \mu_1}{\sigma}$	Conversion of 'u' using Statistical tables	% reduction in waste
	Mean (x)	Standard deviation (σ)			
Bread	1.9	2.9	0.34	0.37	13
Fresh fruit	1.8	1.9	0.53	0.30	20
Cooked meat	-0.2	3.8	0.26	0.40	10
Ready meals	0.8	3.8	0.26	0.40	10
Fresh veg	3.1	3.6	0.28	0.39	11
Salad	2.1	2.9	0.34	0.37	13

[1] Where u is the area under the curve associated with the benefits of extending product life by one day and μ is x +1 (for the additional day)

In **Table 17** we have aggregated the results across each category to show our estimated savings to consumers from increasing the product life available to them by one day. Although the product categories overlap, there is no direct consistency of product used between this study, the Brook Lyndhurst work and the data held by WRAP on household waste; therefore, we have had to assume the behaviours identified by Brook Lyndhurst can be generalised. The 'total waste arisings' data is taken from the WRAP 'Household Food and Drink Waste in the United Kingdom' (2012) study and will include a wider range of products than those in the Brook Lyndhurst study. This quantity is multiplied by the percentage of waste arising due to 'out of date' which was taken from previous studies[32]; estimated to be between 20% and 34% of total household waste arisings. This was then multiplied by the '% reduction in waste' estimates shown in **Table 17** above (note: for fresh veg and salad an average % reduction in waste figure of 12% was used).

Table 17: Estimates of household waste prevention from an additional day of product life

Product type	Total waste arising		Estimated Savings from increasing available life by 1 day.	
	Tonnes	£ millions	Tonnes	£ millions
Bread	560,000	860	14,560-24,750	22.4-38.0
Fresh fruit	910,000	900	36,400-61,880	36.0-61.2
Ready meals	160,000	890	3,200-5,440	17.8-30.3
Fresh veg	1,600,000	1,700	38,400-65,280	40.8-69.4
Salad				
Total	3,230,000	4,350	92,560-157,350	117-199

[32] *WRAP 2008 The Food We Waste report, WRAP 2007 Food Behaviour Consumer Research Findings From The Quantitative Survey: Briefing Paper, and IGD 2007 Household Food Waste report.*

The WRAP 'Household Food and Drink Waste in the United Kingdom' (2012) study estimates that overall 4.2mt at a cost of £12.5 billion of food waste is generated per year in the UK. **Table 17** shows that the estimated savings from increasing product life for households by one day in the five categories falls between 3% (92,560 tonnes/3,230,000 tonnes) and 5% (157,350 tonnes/3,230,000 tonnes). Applying this to the overall total of 4.2mt, provides a sector level estimate of between 0.12mt and 0.21mt, that is a mean savings of 0.17mt.

The value of the waste saved in the five product categories falls between 2.7% (£117m/£4,350m) and 4.6% (£198.9m/£4350m). Applying this to the overall value of £12.5bn provides a sector level estimate of between £0.34bn and £0.58bn with a mean of £0.46bn.

Extending product life could also reduce food waste in those households or for those products where the date wasn't cited or used in the decision making process.

Retailer Benefit

In estimating the benefit for retailers and manufacturers of an extra day of product life we can assume that all date expired waste arises on the use by and/or best before dates because retailers do not sell food products beyond their use-by date.

We have also assumed that the impact of increasing the available life on shelf by one day is directly related to the mean available life, for example increasing the available life by one day on a product with a mean available life of 10 days will reduce the waste arisings by 10%. This assumption is in keeping with the evidence we sighted earlier on the inverse relationship between shelf life and waste. However, we do not have evidence on the overall shape of this curve (except for the products within our business experiment) – which is likely to vary product by product.

Using the results of the retail survey undertaken within this study, **Table 18** shows the estimated impact of increasing the available life by one day. The 'mean date expired losses at retail', shown in **Table 19** were gathered from stakeholder interviews.

Table 18: Calculation of retail waste prevention potential from an additional day of product life

Product type	Sample Size (n)	Mean available life (on-shelf) in days	Mean date expired losses at retail (% sales)	Estimated waste savings from increasing available life by one day (%)
Bread	291	2.9	3.0	1.0
Chicken breast	172	4.7	4.3	0.9
Chicken Kiev	171	4.1	3.5	0.9
Juice	272	35.7	0.4	0.01
Lasagne	131	7.6	3.6	0.5
Milk	58	7.9	0.5	0.1
Pizza	230	4.5	4.7	1.0
Potato	64	4.3	1.3	0.3
Salad	103	3.5	5.5	1.6
Sliced ham	103	12.2	3.5	0.3
Yoghurt	108	13.7	1.4	0.1

Table 19: Estimates of retail waste prevention from an additional day of product life

Product type	Amount purchased by households in 2011 (Tonnes)	Mean date expired losses at retail (% sales)	Estimated date expired losses at retail (Tonnes)	Reduction in date expired losses from extending available life by 1 day	
				(% waste saving)	(Tonnes)
Standard bread	1,600,000	3.0	48,000	1.0	16,000
Poultry (chicken) / turkey / duck	820,000	4.3	35,260	0.9	7,380
Pre-prepared meals	428,000	5.3	22,684	0.9	3,852
Fruit juice and smoothies	1,100,000	0.4	4,400	0.01	110
Milk	5,100,000	0.5	25,500	0.1	5,100
Potato	1,600,000	1.3	20,800	0.3	4,800
Lettuce and leafy salad	170,000	5.5	9,350	1.6	2,720
Sliced ham	236,000	3.5	8,260	0.3	708
Yoghurt / yoghurt drink	479,000	1.4	6,706	0.1	479
Total	11,533,000	1.5	180,960	0.3	41,149

Using the results shown in **Table 18** and the household purchasing data from WRAP's 'Household Food and Drink Waste in the United Kingdom' (2012) study it is estimated that a one-day increase in shelf life would reduce the amount of product wasted at retail by 0.3%. The estimates are shown in **Table 19**. This equates to a 20% reduction in the total date expired waste currently being generated. Using the estimates shown above we have applied this across the total sector level data where the expired waste accounts for 0.4million tonnes at a cost of £0.5billion. This gives an estimate that a 1 day extension to shelf life at retail could reduce waste by 80,000 tonnes with a saving of £0.1billion.

We have not attempted to estimate what proportion of this benefit would fall to manufacturers and what proportion would fall to retailers. Rather, we have assumed that all the benefit accrues to retailers which they then pass on in full to consumers. This benefit therefore cannot be realised twice though we can add the savings above to the consumer benefit (using the mean position) giving a total potential savings in household waste of 0.25mt worth £0.47 billion from a one day extension in shelf life.

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