Reducing supply chain and consumer potato waste

An evaluation of ways to reduce levels of fresh potato waste along the retail supply chain and in the household, including a consumer survey, storage trial, packaging trials and in-store training.
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Legacy research commissioned by the previous government.

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Executive summary

In 2009, WRAP identified that potatoes were one of the items most often wasted in the home1. Around 770,000 tonnes, comprising uncooked fresh potatoes, cooked leftover potatoes and potato peelings, are thrown away each year. Avoidable fresh potato waste amounted to around 290,000 tonnes, valued at around £230 million. To understand to what extent potatoes may also be wasted in the supply chain (growing, storage, packing and retail) WRAP developed a series of resource maps, including one for potatoes2, designed to help reduce waste in the supply chain. The resource map shows that the amount of waste in the supply chain is low compared to that arising from households and generally the level of waste at any particular stage in the supply chain is around 1% to 3%.

In response to an open tender, and in line with their commitment to responsible packaging, Amcor proposed a project to reduce potato waste through the supply chain and in the home. The work built on WRAP’s waste insights, by seeking to understand the reasons for potato wastage in greater detail, and to investigate methods of reducing it. The project comprised several elements: a consumer survey, storage trials, packaging trials and in-store training and communications activity, and the results are summarised below.

Consumer survey
The findings from the consumer survey can be summarised as follows:

- The purchase penetration and purchase frequency of potatoes within UK households underpins the importance of this product in prioritising waste reduction initiatives. While consumers do consider factors such as meal plans and stock of potatoes at home, when it comes to purchasing, there was evidence of habitual purchasing with implications for unnecessary food purchases and consequently food waste. However, people were not unhappy with the size of pack they usually purchased, which suggests they accept potato waste as part of their usual routine, or are not even aware of it.

- It is significant that over 40% of respondents claimed to look at the food date on the pack at point of purchase, that 7.5% would throw potatoes away because they have passed their food date, and that one in six of those who use food dates in their purchase criteria would not buy the pack if a food date was not shown.

- It was encouraging that participants demonstrated awareness that the environmental characteristics of where they store their potatoes at home will have an impact on the shelf life of the product. Indeed, almost two in ten respondents actively chose their storage location because they felt it would keep the product fresher for longer. However, given that potatoes can be stored for as long as one year within the supply chain, it is surprising that 65% of respondents thought potatoes would only last a week or two, something that may be influenced by where they are being stored at home (and, therefore, how quickly they deteriorate). There is potential to improve in-home life through, for example, not storing potatoes in the fridge or light.

- The high penetration of purchases being made in a pre-packed format, along with most potatoes being stored in the original packaging, implies that enhancements in packaging technologies that inhibit undesirable product characteristics (particularly rotting, which was found to be the most significant barrier to purchasing or cooking potatoes) are highly relevant for this market.

- In terms of the main ways in which potatoes are consumed, i.e. boiled and mashed, there is evidence that consumers do make efforts to reuse the excess potatoes in some way if they have cooked too much, although very few stated they would freeze leftover potatoes. (Perhaps because awareness that this is safe and does not impact significantly on product quality is low – again something that could be more clearly communicated on-pack or at point of sale.) Despite the numbers claiming to use leftover cooked potatoes (around half), there were significant numbers of consumers who stated that they would usually throw excess cooked potatoes away (around a quarter).

- With regard to preparing the product, a high proportion of consumers stated that they usually peeled potatoes, with the majority of these respondents disposing of the peelings in the general waste bin, and around a fifth home composting their peelings. Generally, cooked potatoes, like peelings, were also disposed of in the waste bin by nearly half of the consumers surveyed, although nearly a quarter stated that they always ate all the cooked potatoes prepared.

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1 Household Food and Drink Waste in the UK, WRAP November 2009: WRAP announced a reduction in total household food waste of 1.1 million tonnes in October 2011 (www.wrap.org.uk/hfdwfacts). Avoidable food waste reduced by 950,000 tonnes, and the associated value and environmental impact figures have been updated. Research to update our estimates for individual food categories has not yet been carried out, and therefore all figures relating to the breakdown of avoidable food waste should be regarded as approximate. These remain however the best estimates currently available.

2 Resource Map: Fruit and Vegetables, WRAP June 2011
Most respondents disposed of uncooked potatoes in the general waste bin, although some were using the kitchen waste collection service or home composting their potato waste. While just over one in ten respondents claimed not to have thrown away uncooked potatoes, for many respondents, potato condition, particularly rot (59%), mould (47%), sprouting (47%), greening (40%), soft (39%) and slimy (39%) were cited as conditions under which they would throw uncooked potatoes away.

When presented with a series of images illustrating potatoes of varying conditions, a significant number of consumers claimed that they would throw the potato away for all of the four conditions shown (greening, sprouting, rotting and poor skin finish - silver scurf) even though sprouts, rots and poor skin finish do not affect the eating quality if the ‘bad’ bit is removed.

**In-store training**

The in-store training element of the project sought to improve the handling and storage of loose and pre-packed potatoes in the retail environment. A key aspect of the project was to identify good practice and disseminate guidelines for storage and handling of potatoes to prevent waste in the supply chain, and indirectly, in the home. With careless handling and poor storage conditions, potatoes can rapidly deteriorate. Furthermore, once one potato is affected, the others around can also quickly spoil. Training to familiarise staff with approaches to preventing damage, recognising deterioration and understanding how to deal with defects, can be highly effective.

Improvements in potato handling were delivered by Albert Bartlett’s with the co-operation of Sainsbury’s and the Potato Council. The initiative shows that there are opportunities for retailers to optimise the quality of fresh potatoes sold to customers, through training and communication activities, which would then allow for a longer shelf life at home. For example, the avoidance of bruising in the retail environment prevents the onset of defects that may encourage premature disposal in the home. This can be achieved without the need for significant investment, by engendering a culture of careful handling in-store through targeted communication using, for example, staff training, posters and newsletters. All the training materials are available from WRAP for use by packers and retailers.

**Packaging trials**

As shown above, aspects of potato appearance and feel, particularly the presence of rot or mould, sprouting and greening were cited by respondents to the consumer survey as conditions under which they would throw uncooked potatoes away. The high penetration of purchases being made in a pre-packed format, along with most potatoes being stored in the original packaging, implies that enhancements in packaging technologies that inhibit undesirable product characteristics (particularly rotting) could have a significant and positive impact on waste.

The aim of the nine packaging trials, undertaken by the project team, was to look at a number of different fresh potato packaging films, to determine which had the greatest potential to extend the shelf life of specific varieties of potato. From the work conducted, it appeared that the most suitable film for maincrop potatoes was Amcor 20BH microperforated film (120 and 190). This film delayed the greening and sprouting whilst not encouraging the incidence of rots and moulds.

The shelf life extension seen on the trials was between three and four days, but it should be remembered that this was under trial conditions. This would need to be confirmed in the commercial supply chain under practical conditions. Although the 20BH material showed improvements compared to the conventional packaging, the effects on black heart (a physiological condition) need to be fully understood as this condition was identified during the trials. Black heart occurs primarily in storage when the tubers do not receive enough oxygen. The tissue dies from the inside out and turns jet black. It’s not clear whether the black heart was a function of MAP or the film moisture vapour properties. But the results would indicate the depletion of oxygen in the pack has the overriding effect.

When a crop that is susceptible to rots and moulds is to be packed, the most suitable film choice would be the 20BH hole punched material, as this would allow moisture from within the pack to escape to the external atmosphere more efficiently than any other packaging type tested. A 100% print coverage on the face of the retail packaging would reduce greening and extend shelf life.

There is little information linking UV and greening. Therefore, a trial was undertaken to determine whether a PE UV barrier film could more effectively inhibit greening compared to standard PE film. The results show that the UV barrier film did not inhibit greening. Potatoes packed in UV barrier film deteriorated at the same rate as those packed in standard PE film. Assessment scores for overall appearance, sprouting, rot / moulds and greening showed no difference between the two packaging formats.
The packaging trial results suggest the ideal solution, therefore, would be to print the Amcor 20BH and perforate (either microperforated or hole punched), dependent on the crop to be packed. This would allow the optimised film to be utilised throughout the year. Amcor is working with leading potato packers to progress the trials to the commercial level, which could increase shelf life and reduce waste through the supply chain. The results suggest several additional findings:
- Storing potatoes in chilled conditions in the supply chain, increased shelf life by one to two days.
- The process of covering potatoes at night delayed the level of greening occurring on the potatoes, and this should be reinforced throughout the distribution chain.

The lighting used around the potato display in-store should be reduced as much as possible. Three stores were tested for light intensity, where the readings ranged from 850 to 1250 lux, showing that there is potential for lighting levels to be reduced.

**Storage trials**

65% of respondents to the consumer survey thought potatoes would only last a week or two, something that may be influenced by where they are being stored at home. The Potato Council advises consumers\(^3\), that potatoes should ideally be removed from the retail packaging once at home, and stored in a cloth bag. The consumer survey found that just 6% of respondents were storing their potatoes in a cloth bag, with the majority (42%) storing them in the original packaging.

The storage trial compared potato quality over two weeks when stored in two packaging conditions that mimicked those found in home:
- opened and kept in the original plastic packaging, which was polyethylene (PE) hole punched; and
- opened and transferred to a cloth bag designed for storage of potatoes, with the draw-string pulled closed.

For the King Edwards variety the cloth bags offered a benefit by reducing the level of greening, and limiting the level of sprouting compared to the PE hole punched bags. This resulted in a potential home life extension of three days. For the Maris Piper variety the cloth bags reduced the level of moisture within the pack as compared to the PE hole punched pack, which stopped any progression of bacterial breakdown and reduced the level of sprouting.

The results suggest that depending on how quickly potatoes are opened and used after purchase, and their storage location in the home, storing potatoes in a cloth bag in the home could help extend the life of potatoes.

It is suggested that retailers stock suitable cloth bags beside the potato fixture in-store to encourage consumers to optimise their in-home storage, together with improving their storage messaging. For example, ensuring they always recommend storing potatoes in the dark, and in a cool place, not in the fridge (17% of respondents were storing their potatoes in the fridge).

**Recommendations**

Raising awareness of the need to prevent food waste, and providing the tips that will help consumers avoid wasting food are essential.

Several of the solutions to reducing potato waste will come from changing consumer behaviour through effective communications. Love Food Hate Waste ([www.lovefoodhatewaste](http://www.lovefoodhatewaste.com)) is working with partners like the Potato Council and retailers to:
- promote the skills to help consumers portion correctly when preparing potatoes;
- raise awareness of the potential to freeze / use leftover cooked potatoes (25% respondents said they would usually throw leftover cooked potatoes away);
- raise awareness that greening, sprouts, rotts and poor skin finish do not affect the eating quality if the ‘bad’ bit is removed\(^4\);
- help consumers understand what the ‘display until’ and ‘best before’ dates mean\(^5\), given some (44%) consumers used the food date when shopping / deciding whether to eat the product; and
- promote WRAP’s home composting initiative\(^6\) to encourage people to home compost their potato peelings, given the high proportion of respondents that stated they always (42%) or sometimes (44%) peeled potatoes.

\(^3\) [http://www.lovepotatoes.co.uk/faq/#How%20should%20I%20store%20my%20potatoes](http://www.lovepotatoes.co.uk/faq/#How%20should%20I%20store%20my%20potatoes)

\(^4\) It’s best to avoid eating any damaged, green or sprouted parts of potatoes. This is because they can contain high levels of natural toxins called glycoalkaloids. Source: [http://webarchive.nationalarchives.gov.uk/20101224131941/http://eatwell.gov.uk/asksam/healthydiet/fruitandvegg/#A220073](http://webarchive.nationalarchives.gov.uk/20101224131941/http://eatwell.gov.uk/asksam/healthydiet/fruitandvegg/#A220073)

\(^5\) [http://www.lovefoodhatewaste.com/save_time_and_money/food_dates](http://www.lovefoodhatewaste.com/save_time_and_money/food_dates)

\(^6\) [http://www.recyclenow.com/home_composting](http://www.recyclenow.com/home_composting)
Other recommendations from the project are to:
- optimise storage guidance e.g. make sure all packs say ‘store in a cool, dark place’;
- stock suitable cloth bags beside the potato fixture in-store to encourage consumers to optimise their in-home storage
- roll-out further in-store training to staff to improve handling and minimise waste; and
- progress commercial trials of novel materials to enhance shelf-life.
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Acronyms

- CIPC – Chlorpropham
- MA - Modified Atmosphere
- MVTR - Moisture Vapour Transmission Rate
- nm – Nanometre
- PE – Polyethylene
- PP – Polypropylene
- RH - Relative Humidity
- UV - Ultraviolet light
- VFF - Vertical Form Fill
Glossary

Amcor packaging film codes:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>35EA Hole Punched</td>
<td>Polyethylene film with punch holes. 300x350mm external, 300x330mm internal, 7x8mm holes, 2.5kg produce per bag.</td>
</tr>
<tr>
<td>35EA 120</td>
<td>Polyethylene film with microperforations, MA. 300x355mm external, 300x335mm internal, microperforated, 2.5kg produce per bag.</td>
</tr>
<tr>
<td>35EA 190</td>
<td>Polyethylene film with microperforations, MA. 300x355mm external, 300x335mm internal, microperforated, 2.5kg produce per bag.</td>
</tr>
<tr>
<td>35DG Hole Punched</td>
<td>Compostable film with punch holes. 300x300mm external, 300x270mm internal, 9x8mm holes, 2kg produce per bag.</td>
</tr>
<tr>
<td>35DG 120</td>
<td>Compostable film with microperforations, MA. 300x300mm external, 300x270mm internal, microperforated, 2kg produce per bag.</td>
</tr>
<tr>
<td>20BH Hole Punched</td>
<td>High MVTR film with punch holes. 300x355mm external, 300x320mm internal, 8x8mm holes, 2kg produce per bag.</td>
</tr>
<tr>
<td>20BH 120</td>
<td>Nylon film with microperforations, high MVTR MA. 300x355mm external, 300x320mm internal, microperforated, 2kg produce per bag.</td>
</tr>
<tr>
<td>20BH 190</td>
<td>High MVTR film with microperforations, high MVTR MA. 300x355mm external, 300x320mm internal, microperforated, 2kg produce per bag.</td>
</tr>
</tbody>
</table>

Other terms used in the report

- **Black heart**: A physiological disease that occurs when tubers undergo periods of oxygen deprivation. It can occur in the field or in storage. Tubers in transit or storage suffer from the disease when they are poorly ventilated or exposed to freezing or excessively high temperatures.
- **Chlorpropham**: A potato sprouting suppressant.
- **Fresh**: In the context of potatoes, used to mean raw, uncooked.
- **Glycoalkaloid**: A natural toxin found in potatoes at low levels. Can be found at higher concentrations in green, damaged and sprouted parts.
- **High MVTR**: A description for packaging film that has been manufactured to allow higher levels of moisture vapour to pass through than other films.
- **Hole punched**: A treatment for packaging film where punch holes are made at regular intervals to allow the final packaging to 'breathe'.
- **Limiting factor**: A variable that controls a process, such as organism growth. Typical limiting factors in biology include water availability, temperature and light.
- **Lux**: A measure of light intensity.
- **Maincrop**: Varieties such as King Edward or Maris Piper that are harvested in late summer or early autumn, when their skins are firm and set, and are known as 'maincrop'. The majority of potatoes sold in the UK are maincrop potatoes; they are usually available from September to May.
- **Microperforated**: A treatment for packaging film where it is punctured with a series of tiny holes during manufacture, to allow selective gaseous exchange between the interior and exterior atmosphere when used as packaging.
- **Modified Atmosphere (MA)**: A term to describe when the gas mixture within food packaging has been changed so that it is no longer the same as the earth's breathable atmosphere. Usually combined with lowered temperatures, it is a highly effective method for extending the shelf life of food. Modified atmospheres within packs may be added before closure or may be allowed to 'self modify' via respiration.
- **Moisture Vapour Transmission Rate (MVTR)**: A measure of the passage of water vapour through a substance.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nanometre</td>
<td>A unit of length equal to one billionth of a metre, used to measure the wavelength of light.</td>
</tr>
<tr>
<td>P+0</td>
<td>Pack date, the date that product is selected from bulk and packaged.</td>
</tr>
<tr>
<td>P+x</td>
<td>Pack date plus the number of days after the pack date (e.g. P+3 = Pack date plus three days).</td>
</tr>
<tr>
<td>Ultraviolet Light (UV)</td>
<td>Electromagnetic radiation with a wavelength shorter than that of visible light, but longer than X-rays, in the range 10 nm to 400 nm. Invisible to the human eye.</td>
</tr>
<tr>
<td>Vertical Form Fill (VFF)</td>
<td>A type of automated assembly-line product packaging system, commonly used to package food and a wide variety of other products. The machine constructs plastic bags out of a flat roll of plastic film, while simultaneously filling the bags with product and sealing the filled bags.</td>
</tr>
</tbody>
</table>

**Acknowledgements**

Thanks go to the project team responsible for the research behind this report, in particular Steve Pritchard (Amcor Flexibles Europe & Americas), James Lee (Greenvale), Chee W Tao (Albert Bartletts), Stuart Lendrum (Sainsbury’s) and Rachel Gwinn (Department of Food Manufacturing Technologies, Campden BRI).
1.0 Introduction

1.1 Potato production and consumption

The potato market\(^7\) was valued at £1.6 billion in 2008, and grew by 23\% between 2005 and 2008, slightly outpacing the growth of the £10.5 billion market for other fruit and vegetables, which recorded growth of 21\%.

Fresh potatoes account for 65\% of the total potato market in value, and 77\% in volume (with the remainder of the market comprising chilled and frozen pre-prepared potatoes and potato products). Growth of this sector has been driven by packaged potatoes rather than loose. Figure 1 shows data on supply between 2009-10.

**Figure 1:** Flowchart of potato supply, figures for June 2009 to May 2010 crop year, in thousands metric tons raw equivalent

Source: Potato Council (www.potato.org.uk/media_files/MIS_reports/consumption&processingnov2010.pdf)

Potato production is centred in the East of England and Scotland, and is somewhat consolidated, with six suppliers accounting for 60\% of the market. The quantities of fresh potatoes purchased for household consumption have steadily declined since 2003, and in 2009, stood at 537 grams per person per week (TNS data purchased by WRAP). Consumption is relatively stable over the year, but can increase by 10\% to 50\% during Christmas and Jersey Royal/new potato season. Typically, more salad-type potatoes are eaten during Easter and the summer than during the winter months.

There are literally thousands of different varieties of potatoes grown around the world. In the UK around 80 varieties are grown commercially\(^8\). Potatoes are seasonal and are usually harvested from May to October, depending on the variety and where in the country they are grown. Potatoes are often categorised according to their season. For example, varieties such as Rocket or Maris Bard are described as ‘earlies’ or ‘new potatoes’ as they are planted in the winter, ready for harvesting in the spring or early summer. Their skins are not firm and ‘set’. Varieties such as King Edward or Maris Piper are harvested in late summer or early autumn when their skins are firm and set, and are known as ‘maincrop’. The majority of potatoes sold in the UK are maincrop potatoes; they are usually available from September to May.

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\(^7\) Potatoes, Market Intelligence, November 2009, Mintel
\(^8\) http://www.lovepotatoes.co.uk/potato-varieties
The shelf life of potatoes (from harvest to retail sale / consumption) is a minimum of three days (new potatoes without set skins), and up to 270 days for maincrop held in sophisticated long-term storage, ensuring year-round availability. Post-harvest life is reliant not only on variety (innate dormancy and susceptibility to bruising), but also on storage regime (e.g. curing, storage temperature and use of sprout suppressants (CIPC or ethylene supplementation)).

1.2 Potato packaging

1.2.1 Primary packaging
Depending on the weight and variety being sold, potatoes are packaged in a number of formats. All can be packaged loose with a polyethylene (PE) or a polypropylene (PP) liner in returnable trays. New potatoes and salad potatoes are normally sold in PE / PP films with micro perforations to allow them to breathe, typically 30-70 microns. Baking potatoes are normally sold either in a PE or PP bag about 50 microns thick, or in a PS tray with a film overwrap. Red potatoes and other normal cooking potatoes are sold in a variety of weight sizes, and can come in PE or PP bags or nets. They can also be bought loose.

The range of packaging suitable for fresh potatoes is constantly being revised to reflect changing consumer demand and technological developments. For example, modified atmosphere packaging (MA) is increasingly being used for potatoes to extend shelf life, with shelf life potential increased by two days for Jersey Royals and by five days for others. Packaging combining net and film is also now being used. The new packaging offers the consumer a clearer view of the product whilst improving the ‘breathability’ of potatoes. At the same time there is a reduction in packaging weight.

1.2.2 Secondary packaging
Depending on the weight and type of primary packaging, secondary packaging can take the form of corrugated cases, plastic returnable trays with a liner, or stacked on a pallet with shrink wrap (the latter being for sacks).

The plastic returnable trays used by most retailers have a dual function, providing both a means to transport product from packers to store, as well as a way to display fruit and vegetables in store. They also limit the need for staff handling, which reduces the likelihood of product damage.

1.3 Potato waste in the supply chain
The main sources of product loss$ and waste in the fresh potato supply chain, and methods of treatment, are as follows$:

- Field loss and waste can be as much as 5% due to harvest damage (affected by the weather), grade-out, blight, greening, slugs, skin disease and fungal diseases.
- Product can be damaged during harvest through the use of new mechanical technologies.
- Some varieties are more susceptible to deterioration and different seasons or climatic conditions can adversely affect one variety more than another e.g. Maris Piper is prone to rot in wet conditions while Desiree is prone to bruising in cold conditions.
- Soil taken into stores with potatoes during the harvest period can damage them, affecting their grading and acceptability.
- In-store handling. Staff should be encouraged to cover potatoes at night to prevent greening, and loose products can have more waste as they are picked over by customers, which can cause bruising.

This information is also summarised in Table 1. Further detail can also be found in the resource map for potatoes in Appendix A.

<table>
<thead>
<tr>
<th></th>
<th>Field loss (Central range)</th>
<th>Grading loss</th>
<th>Storage Loss</th>
<th>Packing loss</th>
<th>Retail waste</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-2%</td>
<td>3-13%</td>
<td>3-5%</td>
<td>20-25%</td>
<td>1.5-3%</td>
</tr>
</tbody>
</table>

Although it is not possible to develop an accurate benchmark that enables comparison across retailers and suppliers, managing waste is about clear accountability and measurement as well as transparency.

$ Loss - product that is not used for its intended purpose and therefore has no (or very little) value. Losses can be incurred for a variety of reasons and at different points in the chain.
$ Fruit and Vegetable Resource Maps, WRAP, June 2011
IGD Leading Edge Article on WRAP Fruit and Vegetable Resource Maps, Peter Whitehead, IGD, June 2011
The following can help reduce waste in the supply chain:

- As any crop grows and matures, good communication along the supply chain is essential. This is particularly important if the crop is ahead of or behind schedule because of weather conditions.
- Crop planning that is linked to accurate forecasting of customer demands through monthly and weekly plans. Poor forecasting is one of the most common issues identified as a cause of waste.
- Consumer expectations of quality are continually increasing, and it is inevitable that once they are offered better quality, then they expect this quality as standard. Value lines help in this respect, but consumer acceptance of produce is critical. Losses at grading are not sustainable and are usually based on aesthetic appearance or rudimentary quality control measures which in some cases are not recognised by the scientific community as appropriate.
- Finally, one of the main criticisms raised by suppliers is the inflexibility of some retailer specifications to take into account natural variability. This is particularly the case at the transition between seasons and storage regimes. If natural variability and differences in product quality at key periods in the calendar are not taken into account then there will be greater waste and loss in both the field and at grading.

1.4 Potato waste in the household

Fresh vegetables and salad products account for 1.9 million tonnes of total household food waste generated, and are the largest contributor to food waste from a category perspective. Potatoes dominate this waste at 770,000 tonnes, the equivalent of 40% of the category. A detailed breakdown of the ‘most wasted’ vegetables and salad waste is given in Figure 2.

**Figure 2: Weight of vegetables and salad wasted in the household by type, split by avoidability**

![Chart showing weight of vegetables and salad wasted in the household by type, split by avoidability.]

The largest proportion of potato waste comprises potato peelings, which are deemed to be ‘possibly avoidable’ i.e. some people will peel potatoes while others do not. This equates to around 480,000 tonnes per year (three-fifths of fresh potato waste). This is something that could be tackled, for example, by promoting the nutritional benefits within the skin and developing recipes that are designed to include the skin e.g. baked potatoes or potato wedges.

In addition to the possibly avoidable fraction, around 290,000 tonnes of ‘avoidable’ potato waste is also thrown away, which costs £230 million per year. This avoidable waste includes cooked leftover potatoes (98,000 tonnes) and uncooked fresh potatoes, thrown away before they have had any preparation at all (180,000 tonnes).

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11 Household Food and Drink Waste in the UK, WRAP November 2009. Potato waste data includes fresh and processed potato.
The consumer survey element of this project aimed to provide a new understanding about why potatoes are wasted in the home, so that effective solutions to prevent waste could be developed.

1.5 Project team

- Amcor - a global leader in responsible packaging solutions supplying a broad range of plastic (rigid and flexible), fibre, metal and glass packaging products to enhance the products consumers use in everyday life. www.amcor.com

- Greenvale AP PLC - one of the UK's leading suppliers of fresh potatoes, with three fresh packing sites and one processing site strategically located in the key potato growing regions. Greenvale supplies retailers, processors and caterers with both fresh and processed products. www.greenvale.co.uk

- Albert Bartlett & Sons Ltd - one of Britain's leading growers and packers of potatoes. A family business for more than 60 years, they are fiercely committed to natural farming with minimum interference. www.albert-bartlett.co.uk

- Sainsbury's - one of the UK's leading food retailers. Sainsbury's Supermarkets is the UK's longest standing major food retailing chain, having opened its first store in 1869. www.j-sainsbury.co.uk
2.0 Consumer survey

2.1 Aims and objectives
WRAP research has shown there are many factors contributing to household food waste, such as:
- a lack of planning when food shopping - buying more than is needed;
- poor food storage in the home; and
- a lack of confidence around cooking (especially making meals from the food available in the house, using leftovers), portion control and freezing.

Therefore, this part of the project focused on providing insights in relation to the purchase, storage and usage of potatoes.

The survey was designed to:
- examine consumer shopping patterns and practices in relation to fresh potatoes;
- examine fresh potato storage in the home;
- examine fresh potato usage (e.g. mash or boiled etc., whether they are peeled before cooking, propensity to freeze or re-heat leftovers and how any waste is disposed of); and
- gauge consumer reaction to a number of images of potatoes in varying conditions: greening, sprouting, rotting and poor skin finish (silver scurf).

2.2 Survey design and methodology
Campden BRI carried out the consumer research. The survey consisted of in-home interviews, with a representative sample of 2,105 households across 160 locations throughout the UK, between 15th and 19th July 2009.

The survey was conducted via the TNS omnibus survey using a CAPI (Computer Assisted Personal Interviews) system. The TNS CAPI Omnibus employs a random location methodology, using sampling points which are sub-samples of those determined in a sampling system developed by TNS for its internal use.

Interviews were carried out on weekdays from 2pm – 8pm and at the weekend. Quotas were set on gender, presence of children and working status, to ensure a balanced sample of adults within contacted addresses.

Screening questions relating to whether respondents purchased fresh potatoes, the frequency of use of potatoes in a meal, and responsibility for preparing potatoes, were applied to all the interviews. Those not purchasing fresh potatoes (20% of all respondents) were screened out of the remainder of the survey. Respondents who did not use fresh potatoes in a meal in any form were also screened out of the survey (1% of potato buyers), as well as those that did not prepare and / or cook fresh potatoes (12% of buyers and users of potatoes in meals).

2.3 Data analysis
In a number of cases (notably in relation to the potato images), the data were analysed using a statistical two binomial proportions test to establish if there was a statistically significant difference between two results.

In addition to analysis of the results across the whole survey population, major differences between demographic groups, such as lifestage, were also noted.

The definition of the lifestage groups and the proportion each represents of the survey population is shown below in Table 2.

<table>
<thead>
<tr>
<th>Table 2: Lifestage groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-family / no family:</td>
</tr>
<tr>
<td>Family:</td>
</tr>
<tr>
<td>Third Age:</td>
</tr>
<tr>
<td>Retired:</td>
</tr>
</tbody>
</table>

Further information on the survey population can be found at Appendix B.

2.4 Scope
The questionnaire only sought views in relation to fresh, uncut potatoes, and excluded frozen and chilled pre-prepared potatoes and potato products.
2.5 Limitations of the study
The survey design used a random location sampling approach. While this approach is a well-established sampling method, the results are subject to standard sampling errors associated with a survey of this type.

The behaviours recorded in the survey are self-reported. This may have led to some of the reported behaviours being modified to some degree, through the influence of having an interviewer present during completion of the survey. It should also be noted that the survey is based on recalled behaviour, and as a consequence the results may be subject to recall error.

Photographic images were used to reflect different types and stages of deterioration in potatoes. While these images were carefully selected, the variation and consistency in image quality between and within the conditions may have influenced how consumers responded to the questions in this area.

2.6 Results

2.6.1 Fresh potato purchase
Just over eight in ten of all respondents interviewed bought potatoes, and of these 56% were buying once a week and a further 16% once a fortnight. The pre-family lifestage group were generally less frequent buyers than the survey average, with 49% buying once a week.

Nearly two in five respondents (19% - rising to 29% among the retired lifestage group) used potatoes at least daily with a further 62% (rising to 71% among the family lifestage group) stating that they use potatoes a few times a week.

Those respondents who used fresh potatoes were asked to what extent they were responsible for preparation of potatoes in the household. Just over one in ten respondents stated that someone else in the household was always responsible for potato preparation. These respondents did not continue with the survey.

For just over two thirds of respondents who continued with the survey, the usual format for buying potatoes was in a pre-packed format, rising to 75% among the family lifestage group. A further quarter bought potatoes loose, 39% among the retired lifestage group. Of those buying potatoes weekly, just over 70% were buying them pre-packed.

Research undertaken for WRAP\(^{12}\) assessed the proportion of different potato pack sizes available across the major UK retailers\(^ {13}\). Of the 159 packs reviewed, two thirds were sold as 2.5kg packs, with much smaller proportions sold as smaller packs of 1kg (1%), 1.5kg (7%) or 2kg (12%). There were also larger packs available of 5kg (12%) and 7.5kg (2%). Among all respondents to this survey, the 500g-1kg and 2-2.5kg weights were the most popular sizes purchased. The 500g-1kg size was marginally more popular among the pre-family and retired lifestage groups; the 2-2.5kg marginally more popular among the family lifestage group.

Not surprisingly a higher proportion of those buying the 2-2.5kg weight were using potatoes a few times a week (71%) compared to those buying the 500g-1kg weight (56%). A higher proportion of those buying the 500g-1kg weights used potatoes once a week (18%), compared to the 2-2.5kg weight buyers (9%).

Among those buying the most popular pack sizes (500g - 1kg and 2 - 2.5kg weights), the most often cited reason for purchasing this pack size was that it represented the correct amount to last the household until the next shop\(^ {14}\) – around 40% among both groups. At lower levels, but still a significant proportion among those buying the most popular pack sizes, was that the potatoes would stay fresh over the time that they would be used up. Overall nearly one in five stated that they bought the size of pack they usually purchased, out of habit.

Nearly half of all respondents usually bought potatoes from a standard range (59% among the pre-family and 54% among the family lifestage groups), with around a further one in five stating that it varied between value,

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\(^{12}\) Helping Consumers Reduce Food Waste: A Retailer Survey, WRAP, 2010

\(^{13}\) The potatoes that were studied were: mainstream potatoes (often called 'white potatoes' or just 'potatoes'), King Edward potatoes (if unavailable, then all bags of Maris Piper potatoes or Vivaldi potatoes). Any organic options available under these categories but excluding new potatoes, baking potatoes or pre-prepared potatoes (e.g. microwaveable packets of flavoured potatoes).

\(^{14}\) It is important to note that it is not clear from the responses whether the potatoes would 'last' until the next shop because they would all be eaten, or because the respondent felt that any left by the time they next went shopping would not be fresh to eat.
standard and premium ranges. Nearly three quarters of all respondents usually purchased their potatoes from a supermarket – which rose to 83% among those who bought pre-packed bags of potatoes. Among those buying loose potatoes, the proportion buying from a supermarket fell to 59%, with a corresponding wider range of other outlets, such as local markets, used. The retired lifestage group were also less likely to buy from a supermarket (69%).

The reasons for buying from a particular outlet varied. For example, the most often cited reason for buying fresh potatoes from a supermarket was that it was convenient to buy potatoes at the same time as buying other things (56%). For those using a farm shop or local market, quality was the most often cited reason for using these types of outlets.

In terms of general purchase factors (Figure 3), price, what was needed for the ‘weekly shop’, and meal plan considerations were cited as the major factors given by consumers when purchasing potatoes. However, habit was also a major factor, with nearly 10% stating that they always buy potatoes when shopping, and 17% that they always buy the same quantity / pack size.

![Figure 3: Factors taken into consideration when purchasing potatoes (Base: 1481)](image)

When purchasing potatoes, the factors that consumers said they checked for were evidence of rots / rotting (57%), evidence of sprouting (54%) and evidence of greening (45%). Among the pre-family lifestage group, lower proportions checked for these attributes: rots / rotting (43%); sprouting (41%); and greening (30%) respectively.

It is not surprising then, that when respondents were asked to indicate what would put them off buying a particular bag of potatoes, evidence of rots / rotting (72%), sprouting (65%) and greening (56%) were strongly cited by respondents. Again the equivalent results among the pre-family lifestage group were lower than the sample average: rots / rotting (64%); sprouting (52%); and greening (44%) respectively.

The questionnaire sought to understand whether consumers considered the ‘food date’ when purchasing potatoes. Of those respondents who indicated that they did consider food dates at point of purchase (44%), around 16% stated that they would not buy the product if these dates were not shown on the pack. When asked what they would look for in the event that no food date was given on the pack, respondents stated that they would look for evidence of any rotting, sprouting or greening before choosing a pack to purchase. There were no marked differences between lifestage groups.

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15 All four types of food date (display until, sell by, best before, use by) were given within this question to allow for respondents potentially not correctly discriminating between date type.
2.6.2 Fresh potato storage

According to the Potato Council’s ‘Love Potatoes’ website, at home, potatoes should be stored out of the plastic bag in a cloth bag. They should be stored in a cool, dark and airy place and not in the fridge.

In WRAP’s Retailer Survey, the storage guidance given on packs of potatoes was also surveyed. This is shown in Table 3 and indicates that storage guidance was quite consistent across the packs, and gave advice that was in line with that of the Potato Council, except in relation to removing the product from the packaging and putting into a cloth bag. The benefits of storing potatoes in a cloth bag are two-fold: it allows gaseous exchange and prevents the formation of condensation (condensation can increase the speed of bacterial breakdown); and cloth bags tend to be opaque and therefore better at preventing greening. Fourteen per cent of packs also did not advise consumers to store potatoes in a dark place.

Table 3: Storage instructions given on audited packs of potatoes (Base: 157)

| Store in a cool, dark place | 83 | 53% |
| Store in a cool, dry, dark place | 48 | 30% |
| Store in a cool, dry place | 22 | 14% |
| Store in a frost-free, airy, cool, dark, dry place | 3 | 2% |
| Keep refrigerated | 1 | 1% |

Nearly nine out of ten respondents were storing their potatoes inside the house in one of the following locations:

- food cupboard (21%);
- kitchen larder (19%);
- fridge (17%);
- food cupboard with ambient food items e.g. pasta, tins (15%); and
- non-food kitchen cupboard e.g. with kitchen utensils pans (13%).

Although the majority of these locations are likely to be ‘cool and dark’, it is surprising the proportion storing the product in the fridge, when this is almost never given on-pack and is contrary to the Potato Council guidance. A higher proportion of the pre-family group (20%) compared to other lifestage groups stored their potatoes in the fridge.

When asked why they stored their potatoes where they did, among those storing potatoes inside the house, 32% stated that they chose the specific location used because it was dark, 25% because it was cold, and 20% because it was dry. The main reasons cited among those storing potatoes in the fridge were because they kept fresher for longer (45%) and because it's cold (43%). Fourteen per cent of those storing their potatoes inside the house stated that they stored the potatoes where they did because they stayed fresher for longer, 18% because it was convenient for cooking, and a further 14% because there was simply no space anywhere else.

Among those storing potatoes outside the house, 58% did so because it was cold, 32% because it was dark, and 24% because it was dry. Sixteen per cent of those storing their potatoes outside the house stored the potatoes where they did because they stayed fresher for longer, and 21% because there was simply no space anywhere else.

Just over four in ten respondents stored their fresh potatoes in the original packaging. Around 14% stated that they stored potatoes in an uncovered plastic tray / box, 14% in a freestanding vegetable rack and just 6% in a cloth bag.

Across the survey population, 87% of all respondents expected potatoes to last for 21 days or less. The majority of respondents (42%) believed potatoes last up to 7 days, 23% up to 14 days and 22% up to 21 days, with the remainder (13%) stating a longer life than 21 days. (This did not vary markedly between those respondents storing potatoes inside or outside the house.)

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16 [http://www.lovepotatoes.co.uk/faq/#How%20should%20I%20store%20my%20potatoes](http://www.lovepotatoes.co.uk/faq/#How%20should%20I%20store%20my%20potatoes)
17 Helping Consumers Reduce Food Waste: A Retailer Survey, WRAP, 2010
A higher proportion (28%) of those respondents storing potatoes in a fridge expected potatoes to last up to 14 days, compared to those storing them in a larder or non-food cupboard (both at 19%). A higher proportion (48%) of those storing their potatoes in a food cupboard expected potatoes to last up to 7 days compared to those storing them in a fridge (39%). (Small sample sizes make it difficult to draw definite conclusions on the relationship between storage location and level of disposal of unused fresh potatoes, the latter also being influenced by the frequency of purchase and use.)

Given that, prior to retail, potatoes can be stored for as long as one year, it is surprising that 65% of respondents thought potatoes would only last a week or two. It is not clear to what extent this view is informed by the food dates given on-pack, and people’s general understanding that a ‘best before’ date indicates the date at which the product is at its best, not the date at which it becomes unsafe to eat.

2.6.3 Fresh potato consumption and disposal
Boiled potatoes were the most frequently cited form of cooked potatoes consumed (73% of respondents consume potatoes in this way), followed by mash (62%). Roast and baked potato formats were both consumed by just over half of all respondents in total.

A lower proportion of the pre-family and family lifestage groups (34% and 32% respectively) most frequently consumed boiled potatoes compared to the retired group (60%). A higher proportion of the pre-family and family lifestage groups (26% and 29%) respectively most frequently consumed mashed potatoes, compared to the retired group at 14%.

While meal type not surprisingly influences how potatoes are cooked (46%), simply what they wanted to cook (35%) and who they were cooking for (20%) were also cited by respondents as important considerations. Twenty-one per cent commented that potato size would be an influence on how fresh potatoes are cooked, 14% that potato quality would be an influence, 11% that the state of the potatoes would be an influencing factor, and 8% the age of the potatoes.

In terms of meal quantities per pack, 45% of those buying the most popular pack size (2 - 2.5kg weight) expected to get five or more meals¹⁸ and 55% of those buying the 500g - 1kg pack weight expected to get two to three meals.

Just over four in ten respondents stated that they always peeled potatoes before cooking and eating them, contributing to the 480,000 tonnes of possibly avoidable potato waste noted in the introduction to this report. Just 15% of respondents did not usually peel their potatoes, though for the majority (43%) of respondents, whether or not they peeled the potatoes depended on the type of dish being prepared and / or the quality of potatoes being cooked (e.g. if the potato skin finish was not particularly good, people who would not usually peel the potato may do so).

Among those respondents who usually boiled their potatoes, just over a fifth stated that they would not usually have any left over (Figure 4); this was higher among the retired group (25%) compared to the other groups.

However, despite advice from the Food Standards Agency that boiled potatoes can be stored in the fridge for up to two days¹⁹, around a quarter of respondents stated that they usually threw leftover boiled potatoes away if they had cooked too much. However, half of those respondents who usually boiled potatoes kept leftovers either in the fridge or freezer for future use, or to make into another dish. The Potato Council advises that potatoes can be frozen²⁰, yet a very low proportion (less than 5%) of people were doing this.

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¹⁸ This question asked ‘approximately how many individual meals do you expect to get from the weight of potatoes that you usually buy?’ Individual meals meant the number of servings, for example for a family of four this would be four meals. However, from the responses, it would seem this was mis-interpreted to mean number of total meals.

¹⁹ http://www.lovepotatoes.co.uk/faq/#How%20long%20can%20I%20keep%20leftover%20potatoes%20in%20the%20fridge?

²⁰ The Potato Council advises that for potatoes that need using up consumers can parboil them for 6 minutes, drain them and when they are cool, freeze them. They can stay in the freezer for up to a month and should be defrosted in the fridge. They advise that consumers freeze the potatoes on a baking tray, so they’re not touching each other, and when they are solid, pop them in a plastic bag. This stops them being stuck together so you don’t have to defrost them all at once.
While just over one in ten respondents claimed not to have thrown away uncooked potatoes, for many respondents potato condition, particularly rot (59%), mould (47%), sprouting (47%), greening (40%), soft (39%) and slimy (39%), was cited as a reason they have thrown, or would throw, uncooked potatoes away. Just under ten per cent would throw potatoes away because they had passed their food date.

Of those who threw away uncooked potatoes, nearly six out of ten disposed of them by throwing them away in the general waste bin - this was highest among the pre-family group at 71%, and lowest among the retired group at 54%. A further 20% disposed of them in a home composter and 14% through their kitchen waste collection.

While nearly a quarter (24%) stated that they always eat all their cooked potatoes, 47% stated that if they did not eat them all, they would throw them away in the general waste bin - this was highest among the pre-family group at 61%, and lowest among the retired group at 37%. Use of kitchen waste collection and a home composter for disposal of cooked potatoes were at lower levels of 11% and 9% respectively.

Of those respondents who peel potatoes, just over six in ten stated that they disposed of peelings in the general waste bin; 69% among the pre-family group and 53% among the retired group. Use of a home composter for disposal of peelings was cited by 22% of respondents, with kitchen waste collection being used by 14% of respondents.

### 2.6.4 Consumer response to potato images

Respondents were shown eight images of potatoes in different conditions - two for each condition covering greening, rot, poor skin finish (silver scurf) and sprouting. These are shown below (Figures 5-8), together with the results.
**Figure 5:** Potato images – greening

Greening Stage 1

![Greening Stage 1](image1)

Greening Stage 2

![Greening Stage 2](image2)

**Figure 6:** Potato images – rot

Rot Stage 1

![Rot Stage 1](image3)

Rot Stage 2

![Rot Stage 2](image4)
**Figure 7:** Potato images - silver scurf

![Silver Scurf Stage 1](image1.png) ![Silver Scurf Stage 2](image2.png)

**Figure 8:** Potato images - sprouting

![Sprouting Stage 1](image3.png) ![Sprouting Stage 2](image4.png)
Table 4: Table of results for potato images – greening and rots

<table>
<thead>
<tr>
<th></th>
<th>Greening stage 1</th>
<th>Greening stage 2</th>
<th>Rot stage 1</th>
<th>Rot stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>%</td>
<td>Count</td>
<td>%</td>
</tr>
<tr>
<td>Cook it all</td>
<td>813</td>
<td>54.9</td>
<td>650</td>
<td>43.9</td>
</tr>
<tr>
<td>Cut off the bad bit and cook the rest</td>
<td>119</td>
<td>8</td>
<td>116</td>
<td>7.8</td>
</tr>
<tr>
<td>Peel off the bad bit and cook the rest</td>
<td>170</td>
<td>11.5</td>
<td>152</td>
<td>10.3</td>
</tr>
<tr>
<td>Cut and peel off the bad bit and cook the rest</td>
<td>164</td>
<td>11.1</td>
<td>138</td>
<td>9.3</td>
</tr>
<tr>
<td>Total – eat all or part</td>
<td>1266</td>
<td>85.5</td>
<td>1056</td>
<td>71.3</td>
</tr>
<tr>
<td>Throw it away</td>
<td>163</td>
<td>11</td>
<td>367</td>
<td>24.8</td>
</tr>
<tr>
<td>Don't Know</td>
<td>52</td>
<td>3.5</td>
<td>58</td>
<td>3.9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1481</td>
<td>100</td>
<td>1481</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 5: Table of results for potato images – silver scurf and sprouting

<table>
<thead>
<tr>
<th></th>
<th>Silver scurf stage 1</th>
<th>Silver scurf stage 2</th>
<th>Sprouting stage 1</th>
<th>Sprouting stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>%</td>
<td>Count</td>
<td>%</td>
</tr>
<tr>
<td>Cook it all</td>
<td>258</td>
<td>17.4</td>
<td>188</td>
<td>12.7</td>
</tr>
<tr>
<td>Cut off the bad bit and cook the rest</td>
<td>188</td>
<td>12.7</td>
<td>164</td>
<td>11.1</td>
</tr>
<tr>
<td>Peel off the bad bit and cook the rest</td>
<td>364</td>
<td><strong>24.6</strong></td>
<td>340</td>
<td><strong>23</strong></td>
</tr>
<tr>
<td>Cut and peel off the bad bit and cook the rest</td>
<td>224</td>
<td>15.1</td>
<td>169</td>
<td>11.4</td>
</tr>
<tr>
<td>Total – eat all or part</td>
<td>1034</td>
<td>69.8</td>
<td>861</td>
<td>58.2</td>
</tr>
<tr>
<td>Throw it away</td>
<td>362</td>
<td><strong>24.4</strong></td>
<td>518</td>
<td><strong>35</strong></td>
</tr>
<tr>
<td>Don't Know</td>
<td>85</td>
<td>5.7</td>
<td>102</td>
<td>6.9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1481</td>
<td>100</td>
<td>1481</td>
<td>100</td>
</tr>
</tbody>
</table>

For greening, surprisingly, most people stated that they would ‘cook it all’, as indicated by 55% for Stage 1 and 44% for Stage 2. Similar responses between the stages were shown for the other options, apart from ‘throw it away’ where a statistically significant, higher percentage of people (25%) indicated that they would throw Stage 2 away, as compared to 11% for Stage 1.

For rotting, the most popular selection was to ‘cut off the bad bits and cook the rest’ as indicated by 47% for Stage 1 and 38% for Stage 2, followed by ‘cut and peel off the bad bit, cook the rest’ as indicated by 28% and 25% respectively. The Stage 2 potato accrued slightly lower counts for ‘cutting away the bad bits and cook the rest’, with a statistically significant higher percentage at 30% indicating that they would ‘throw it away’, as compared to 17% for Stage 1. A very low 1% indicated that they would ‘cook it all’, with 6% and 5% indicating that they would just ‘peel off the bad bit, cook the rest’.

For silver scurf, again, both stages showed similar responses, with the most popular choices being to ‘peel off the bad bit, cook the rest’ or ‘throw it away’. For the Stage 1, a fractionally higher percentage at 25% indicated that they would ‘peel off the bad bits’, as opposed to 23% for Stage 2, with a statistically significant higher 35% indicating that they would ‘throw away’ Stage 2 as opposed to 24% for Stage 1.

For sprouting, both stages showed similar responses, with the most popular choices being to ‘cut off the bad bit, cook the rest’ or ‘throw it away’, followed by ‘cut and peel off the bad bit, cook the rest’. For the Stage 1, a fractionally higher percentage at 31% indicated that they would ‘cut off the bad bits’ as opposed to 29% for Stage 2, with a statistically significant higher 35% indicating that they would ‘throw away’ Stage 2 as opposed to 29% for Stage 1. Between 21-22% would ‘cut and peel off the bad bit, cook the rest’ for both stages.
What the consumer reaction tests show (Figure 9) is that respondents were more likely to eat all or part of a green potato than for any other condition. Sprouty potatoes and those with a poor skin finish (silver scurf), conditions which have no effect on eating quality, surprisingly, seemed the most likely to be thrown away.

The Potato Council advises consumers that “although green potatoes show that the alkaloid solanine has formed, which is poisonous, partially green potatoes are still safe to eat – just cut away the green bits”[21]. The FSA provides more detailed guidance, shown in the box below.

**Are green bits on potatoes bad for you?**

It’s best to avoid eating any green bits on potatoes. This is because they can contain high levels of natural toxins called glycoalkaloids. Glycoalkaloids are usually found in potatoes at low levels. But they can be higher in: green parts, damaged parts and sprouted parts.

High levels of glycoalkaloids can upset the digestive system and cause symptoms such as abdominal pain, vomiting and diarrhoea. But glycoalkaloid poisoning is extremely rare, even though potatoes are eaten in very large amounts in many countries.

To avoid high levels of glycoalkaloids being produced in potatoes, store them in a dark, cool and dry place. And remember not to eat any damaged, green or sprouted parts. If potatoes still taste bitter after you’ve removed these bits, it’s better not to eat them, because they could contain high levels of glycoalkaloids.


**Figure 9: Summary table from consumer reaction tests**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Eat all/part</th>
<th>Throw away</th>
<th>Don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greening (1)</td>
<td>10</td>
<td>90</td>
<td>0</td>
</tr>
<tr>
<td>Rot (1)</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Silver scurf (1)</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Sprouting (1)</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Greening (2)</td>
<td>10</td>
<td>90</td>
<td>0</td>
</tr>
<tr>
<td>Rot (2)</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Silver scurf (2)</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Sprouting (2)</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

This evidence suggests it would be beneficial to communicate clear guidance on how to treat green, sprouted and damaged potatoes more widely to consumers e.g. at point of sale.

[21] [http://www.lovepotatoes.co.uk/food-budgeting/]
2.7 Recommendations
These insights led to the following specific recommendations, in order to tackle potato waste in the home.

2.7.1 Cooked, leftover potatoes
To tackle the 98,000 tonnes of cooked, leftover potatoes that are thrown away:

- The Potato Council, potato industry and retailers could support activities promoted by Love Food Hate Waste (www.lovefoodhatewaste) to use leftover cooked potatoes e.g. making them into a potato salad to take to lunch the next day. The Love Food Hate Waste website has many leftover recipe ideas for potatoes. Leftovers can be stored for up to two days in the fridge or frozen.
- Love Food Hate Waste partners can continue to raise awareness of the importance of portioning correctly when cooking potatoes. The Love Food Hate Waste website has a portion calculator which can help ensure the right amount of potatoes are cooked (Figure 10).
- Although cooking advice was found on 82% of packs in WRAP's retailer survey, just 34% of packs were found to have portioning advice (all as part of a recipe), something that could be increased and greatly help reduce the significant proportion of cooked leftover potatoes that are thrown away.

Figure 10: Portion calculator on Love Food Hate Waste

2.7.2 Uncooked potatoes
To tackle the 180,000 tonnes of uncooked potatoes, thrown away before they have had any preparation at all:

- Consumers demonstrated an awareness that where they store their potatoes at home will have an impact on the shelf life of the product. Advice from the Potato Council is that in-home life can be extended by removing potatoes from the plastic packaging at home, and storing them in a cloth bag. This guidance could be more often stated on pack or at point of sale since just 6% of respondents were found to do so. Retailers could support this behaviour by selling suitable cloth bags next to the potato fixture, and / or running a promotion with in-store handouts to encourage uptake.
- Given consumers’ desire for convenience, it is anticipated that this will be a difficult behaviour to embed and therefore innovations around the plastic packaging, e.g. MA, could still be beneficial. Further, the high

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22 Household Food and Drink Waste in the UK, WRAP, November 2009
23 http://www.lovefoodhatewaste.com/everyday_perfect_portions
24 Helping Consumers Reduce Food Waste: A Retailer Survey, WRAP, 2009
penetration of purchases being made in a pre-packed format means that enhancements in packaging technologies that inhibit undesirable product characteristics should be pursued.

- Improvements to where consumers store potatoes at home, i.e. in a cool, dry, dark place and not in the fridge, could help reduce what is thrown away by increasing in-home life. At refrigerated temperatures enzymes are activated that breakdown starch to sugars, which can affect cooked potato taste and texture. Storage guidance on-pack could be made explicit about not storing potatoes in the fridge.
- Communicate advice on how to freeze potatoes not likely to be used in time; simply parboil them for about six minutes, cool and freeze (ideally on a baking tray so they don’t stick together, once frozen they can be transferred to a plastic bag).
- The Potato Council, potato industry and retailers could help raise awareness that greening, sprouts, rots and poor skin finish do not affect the eating quality if the ‘bad’ bit is removed. Figure 11 shows current guidance on the Potato Council website.
- Given some (44%) consumers used the food date, it is important that consumers understand what the ‘display until’ and ‘best before’ dates mean, so that they do not throw perfectly good potatoes away unnecessarily. This should continue to be communicated by Love Food Hate Waste and its partners, especially retailers at point of sale, for example.
- In terms of general purchase factors, habit was also a major factor, with nearly 10% stating that they always buy potatoes when shopping, and 17% that they always buy the same quantity / pack size, which could result in consumers buying too much. This could be a difficult behaviour to challenge particularly where consumers do not recognise the problem. Continuing to provide a good range of pack sizes and continuing to raise awareness of the environmental impact of food waste through Love Food Hate Waste are recommended. Improving in-home life (through optimal storage conditions) could help to ensure that the amounts bought have a better chance of being eaten. Encouraging everyone to ‘add another potato meal’ each week should also be supported.

**Figure 11:** Guidance from the Potato Council website on eating potatoes that have gone green or sprouted

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2.7.3 Potato peelings
To tackle the 480,000 tonnes of potato peelings that are thrown away:

- A high proportion of consumers stated that they usually peeled potatoes. WRAP’s home composting initiative encourages and supports people to take up home composting and this could be promoted, for example, at point of sale and in local media. Home composting would also be a viable alternative to dispose of the uncooked potatoes that respondents admitted to occasionally throwing away.
- The potato industry and retailers could encourage consumers to eat potatoes with the skins on, which have nutritional benefits as they are a concentrated source of dietary fibre, for example by developing more recipes where ‘skin-on’ potatoes are used or industries for the potato peelings such as home-made oven baked crisps.

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25 [http://www.lovepotatoes.co.uk/faq/#Should%20I%20eat%20potatoes%20that%20have%20sprouted?](http://www.lovepotatoes.co.uk/faq/#Should%20I%20eat%20potatoes%20that%20have%20sprouted?)

3.0 Storage trial

3.1 Aims and objectives

The Potato Council advises consumers to: “Get your potatoes out of the plastic bag and into a cloth bag. Choose somewhere cool, dark and airy - not the fridge”.

With this advice in mind, this part of the project aimed to establish how the way in which people store potatoes in the home affects their shelf life, by observing conditions such as greening, sprouting and rotting. This was specifically with regard to the wrapping surrounding the potatoes, rather than the storage location.

3.2 Methodology

3.2.1 Product and packaging details

A trial was undertaken to compare potato quality over two weeks when stored in two packaging conditions:

- opened and kept in the original plastic packaging, which was polyethylene (PE) hole punched; and
- opened and transferred to a cloth potato bag designed for storage of potatoes, with the draw-string pulled closed.

Two varieties of fresh potatoes were used to compare their performance: King Edwards and Maris Piper. The cloth bag used was an 'Eddingtons Potato Storage Bag', as shown in Figure 12. This is a cotton bag made with a blackout lining, which aims to reduce the contents’ rate of ageing, has a drawstring top, and also a side zip to allow older potatoes to be removed from the base of the bag. It measures 39cm by 28cm.

Figure 12: Photograph of the Eddingtons Potato Storage Bag

3.2.2 Trial details

The trials followed identical conditions to reduce unintended variability:

- The tests were started on the same day.
- The potatoes had identical ‘best before’ dates, to ensure as far as possible that they were the same age.
- The potatoes were stored in the lab at Amcor, in reduced light.
- The tests were run for a period of two weeks.

All the potatoes were purchased on 8 October 2010, and half the samples were packed into the cloth bags on this day, the remainder being left in their retail packaging. The King Edwards had a ‘display until’ date of 10 October and a ‘best before’ date of 12 October. The Maris Piper potatoes had a ‘display until’ date of 10 October and a ‘best before’ date of 14 October.

Shelf life assessments were undertaken daily over the two-week trial period, with the potatoes scored for general appearance, greening, rotting and moulds, and sprouting, in accordance with Table 6.

General appearance

The samples were scored on a scale spanning ‘very poor’ (1) to ‘excellent’ (5). In addition to scoring for general appearance, photographs were taken throughout the trial to show any differences where applicable.

27 http://www.lovepotatoes.co.uk/faq/#How%20should%20I%20store%20my%20potatoes
Greening, rots and moulds
These variables were assessed and marked on a scale from ‘100% of potatoes affected’ (1) to ‘very slight / none present’ (5).

Sprouting
An assessment of sprouting was carried out each day, whereby the percentage of potatoes affected was recorded along with the length of sprouts in mm.

Weight loss
The samples were also weighed at the start of the trial, and again at the end to determine levels of weight loss.

Black heart
All the potatoes in both packaging regimes were cut open and assessed for black heart at the end of the trial.

Table 6: Scales used for shelf life assessments

<table>
<thead>
<tr>
<th>Overall appearance</th>
<th>Rots and Moulds</th>
<th>Greening</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very poor</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Poor</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Average / Acceptable</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Good</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Excellent</td>
<td>1</td>
</tr>
</tbody>
</table>

3.3 Results
The results are presented in a series of bar charts, with the following key:
- MP HP – Maris Piper potatoes stored in PE hole punched polyethylene (original retail packaging);
- MP CB – Maris Piper potatoes stored in cloth bag;
- KE HP – King Edward potatoes stored in PE hole punched polyethylene (original retail packaging); and
- KE CB – King Edward potatoes stored in cloth bag.

3.3.1 Appearance
Figure 13 shows the appearance scores. For Maris Piper:
- There were no differences between the cloth bag or PE hole punched treatments until 15 October (their ‘best before’ date was 14 October). Up to the 15 October, both were still considered acceptable in appearance (score of 3).
- Neither treatments were considered acceptable at 18 October, with the appearance of the potatoes in the PE hole punched bag scoring slightly lower than those in the cloth bag.
- The limiting factor of the appearance of the Maris Piper potatoes in the PE hole punched pack was the level of sprouting and the developing rots on isolated tubers.
- The limiting factor of the appearance of the Maris Piper potatoes in cloth bags was the visible signs of dehydration and dulling.

For King Edwards:
- Differences were seen in the King Edwards in the PE hole punched pack from 11 October onwards. At this point the potatoes were starting to green. This progressed rapidly throughout the test, with the potatoes rated as acceptable only up to 12 October, which was their ‘best before’ date.
- Greening was prevented in the cloth bag treatment.
- From 15 October the instance of sprouting had increased in both King Edward treatments, which led to the cloth bag treatment scoring below acceptable after 15 October.
3.3.2 Greening
The only treatment to show significant greening was the King Edwards in the PE hole punched bags, where the tubers were exposed to reduced light\textsuperscript{28} (Figure 14). The potatoes packed in the cloth bags were obviously shielded from light and hence did not green.

The Maris Piper variety is not so susceptible to greening and hence very little greening was observed and then only in the PE bag, not the cloth bag, on 21 October.

\textsuperscript{28} The potatoes were stored in a doorless cupboard in the lab at Amcor. Light levels were therefore reduced, but not completely dark. The lux levels in the lab are at 600 lux at benchtop level, within the cupboard the lux levels are at 100 lux.
3.3.3 Rots and moulds

No rots or moulds were seen in either King Edward treatments throughout the trial (Figure 15).

Rots were visible within the Maris Piper PE hole punched bags from 12 October, where the odd tuber was observed to show signs of mechanical damage that fairly quickly started to rot. This was due to moisture retention and high humidity levels within the PE hole punched packs, which provide ideal conditions to accelerate bacterial breakdown of this sort.

In the cloth bags, the Maris Piper tubers were drier to the touch as compared to the PE hole punched packs, hence the tubers observed with mechanical damage did not progress to bacterial breakdown as seen in the PE hole punched packs.

However, although rots were identified for the Maris Piper in the PE hole punched packs, the incident level was low, and hence the scoring remained acceptable (above 4).

Figure 15: Rots and moulds scores
3.3.4 Sprouting
The first signs of sprouting were seen from 13 October in the Maris Piper cloth bag. From 15 October all treatments were beginning to sprout, and the PE hole punched treatments showed a greater progression of sprouting as compared to the cloth bag treatments. This trend continued for the remainder of the trial.

Figure 16: Sprouting scores

3.3.5 Weight loss
Minimal weight loss was observed in the PE hole punched packs, typically just over 1%, as compared to the cloth bags that lost approximately 3%. This was also observed during the trial, where the tubers in the PE hole punched bags were wet to the touch compared to very dry tubers in the cloth bag.

Figure 17: Weight loss at P+9

3.3.6 Black heart
No potatoes were seen to be affected by black heart in this trial.
3.4 Conclusions

For the King Edwards variety the cloth bags offered a benefit by reducing the level of greening, and limiting the level of sprouting compared to the PE hole punched bags. This resulted in a potential home life extension of three days, based on the criteria of the trial protocol.

For the Maris Piper variety the cloth bags reduced the level of moisture within the pack as compared to the PE hole punched pack, which stopped any progression of bacterial breakdown and reduced the level of sprouting.

Although these positive attributes were observed, there was a difference between the levels of dehydration, where both varieties' tubers in the cloth bags were certainly more wrinkled and dull due to higher levels of dehydration.

The results suggest that depending on how quickly potatoes are opened and used after purchase, and their storage location in the home, storing potatoes in a cloth bag in the home, could help extend the life of potatoes.

3.5 Recommendations

It is suggested that retailers stock suitable cloth bags beside the potato fixture in-store to encourage consumers to optimise their in-home storage, together with improving their storage messaging. For example, ensuring they always recommend storing potatoes in the dark, and in a cool place, not in the fridge (17% of respondents were storing their potatoes in the fridge).
4.0 Packaging trials

4.1 Aims and objectives
The aim of these trials was to look at a number of different fresh potato packaging films, to determine which had the greatest potential to extend the shelf life of specific varieties of potato. Amcor undertook the trials.

As shown in Section 2, the factors that particularly put consumers off buying a bag of potatoes include evidence of rotting and moulds, sprouting and greening. These are taken as signs of deterioration, and lead to fresh potatoes being disposed of. Alternative packaging types may reduce the prevalence of these conditions, extend the shelf life of the produce, and reduce wastage both in the supply chain and in the home.

One of the solutions assessed was the use of MA. The use of MA has proven that the shelf life of a wide range of vegetable products can be extended. The food industry has been involved in trials using this technology since the mid-1980s on a wide range of fruit and vegetable products. Additionally, special films have been developed that are suitable for these types of products. Amcor was the first material supplier involved in the MA packing of new potatoes and baking potatoes, and the prevention of greening in Jersey potatoes. Amcor also has a commercial solution in the US using MA and high MVTR films to help prevent greening and rotting of local potato varieties. The relative performance of these films was tested and compared during the trials.

4.2 Methodology
A wide range of variables were tested during 9 trials, and these are set out in full alongside the results in Section 4.3. The following sections summarise the variables and describe the shelf life assessments made.

4.2.1 Film / packaging, potato varieties and conditions used
Eight alternative packaging films were trialled, covering a combination of the following variables:
- film composition, comprising polyethylene, compostable, or nylon;
- hole punched films, with a selection of hole sizes; and
- films with microperforations.

The potato varieties most used for the trials were Maris Piper and King Edward. However, certain trials also used:
- baby new potatoes;
- Estima;
- Saxon; and
- Charlotte.

Light levels
The samples were stored in constant light (800 lux) 24 hours per day, except for one trial (5b), where two lighting regimes were compared: constant light (800 lux) versus constant light (800 lux) for 18 hours and covered for six hours. This was considered to most accurately replicate typical retail store conditions.

Temperatures
Each trial used either a single temperature for its duration, or a combination of temperatures. The temperature regimes were: ambient (18-20°C); semi-chilled (10-12°C); and chilled (8-10°C).

4.2.2 Shelf life assessments
Throughout the trial, assessments were made of overall appearance, rots and moulds and greening on arrival and then daily on all samples. Samples were scored for overall appearance on a scale spanning from 'very poor' (1) to 'excellent' (5). Rots and moulds and greening were scored using the following scale:
1 - 100% of potatoes affected
2 - 75% of potatoes affected
3 - 50% of potatoes affected
4 - 25% of potatoes affected
5 - Very slight / none present.

Assessment of sprouting was also carried out daily and the length of sprouts in mm recorded. Photographs were taken daily to provide as much consistency as possible. Once the scores for the samples dropped below 3, the samples were deemed no longer acceptable and the trial was stopped (point of destruction). Prior to destruction, the samples were cut open to determine any presence of black heart.
## Summary of trials

<table>
<thead>
<tr>
<th>No</th>
<th>Date / Packer</th>
<th>Objective</th>
<th>Trial Details</th>
<th>Results</th>
</tr>
</thead>
</table>
| 1  | August 2009 / Albert Bartletts | To trial an increased level of hole punched perforations on 1kg Baby New Potatoes to determine if quality can be improved over current packaging | - Current film (8x8mm holes)  
- Trial film (11x8mm holes)  
- Two temperature regimes assessed: ambient 18-20°C, and a variable regime (to build moisture in the packs) | - No difference found in quality of these potatoes — in either packaging set.  
- Shelf life limiting factor was the level of greening seen.  
- No shelf life extension gained on this product. |
| 2a | November 2009 / Greenvale AP | To trial a variety of packaging under a variety of conditions to determine the packaging which gave the best performance. | - Estima variety (James Lee specifically picked this crop due to its susceptibility to rots and moulds)  
- Two temperature regimes (ambient 18-20°C and semi-chilled 10-12°C).  
- Films used: 35EA Hole Punched, 35EA120, 35DG Hole Punched, 35DG120, 20BH Hole Punched, 20BH120  
- Loose potatoes were assessed vs. packaged product. | - Limiting factor on standard microperforated film was the level of rots seen. The limiting factor on all the other films, and loose product, was the level of greening seen.  
- The cooler temperature regime did delay the greening, rots and moulds and sprouting.  
- The high MVTR MA films delayed the greening whilst at the same time not encouraging the level of rots / moulds.  
- Using a cooler storage temperature extended the shelf life by approximately 1-2 days.  
- Using a high MVTR MA base film extended the shelf life by at least 1-2 days. |
| 2b | November 2009 / Greenvale AP | To carry out the same as above but with ‘abused’ potatoes (subjected to higher temperature / humidities). | - Estima variety, but ‘abused’ to increase the likelihood for rots and moulds occurring. (James Lee specifically picked this crop due to its susceptibility to rots and moulds)  
- Two temperature regimes (ambient 18-20°C and semi-chilled 10-12°C).  
- Films used: 35EA Hole Punched, 35EA120, 35DG Hole Punched, 35DG120, 20BH Hole Punched, 20BH120  
- Loose potatoes were assessed vs. packaged product. | - Limiting factor on standard microperforated film was the level of rots seen. The limiting factor on all the other films, and loose product, was the level of greening seen.  
- The cooler temperature regime did delay the greening, rots and moulds and sprouting.  
- The high MVTR MA films delayed the greening whilst at the same time not encouraging the level of rots and moulds.  
- Using a cooler storage temperature extended the shelf life by approximately 1-2 days.  
- Using a high MVTR MA base film extended the shelf life by at least 1-2 days. |
<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Objective</th>
<th>Methods</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 3a January 2010 – Albert Bartletts | To trial a variety of packaging on King Edwards potatoes to determine the packaging which gave the best performance. | King Edwards  
Ambient temperature (18-20°C)  
Constant light  
Films used: 35EA Hole Punched, 35EA120, 35DG Hole Punched, 35DG120, 20BH Hole Punched, 20BH120. | Limiting factor on standard microperforated film was the level of sprouting seen. The limiting factor on all the other films was the level of greening seen.  
The high MVTR MA films delayed the greening whilst not encouraging the level of sprouting seen on the standard microperforated film.  
Amcor 20BH120 had the least amount of greening and sprouting found than any other packaging trialled.  
Using Amcor 20BH120 (high MVTR MA) extended the shelf life by at least 4 days, under these conditions. | |
| 3b February 2010 - Greenvale | To trial a variety of packaging for King Edward potatoes to determine the packaging which gave the best performance. | King Edwards  
Ambient temperature (18-20°C)  
Constant light  
Films used: 35EA Hole Punched, 35EA120, 35DG Hole Punched, 35DG120, 20BH Hole Punched, 20BH120  
Loose potatoes were assessed vs. packaged product. | Limiting factor on all films was the level of greening seen.  
The high MVTR MA films delayed the greening whilst not encouraging the level of sprouting or rots seen on the standard microperforated film.  
Amcor 20BH120 had the least amount of greening and sprouting found than any other packaging trialled.  
Using Amcor 20BH120 (high MVTR MA) extended the shelf life by at least 4 days, under these conditions. | |
| 4 February 2010 - Greenvale | To trial a variety of packaging for King Edward potatoes to determine the packaging which gave the best performance. | King Edwards  
Semi-chilled temperature (10-12°C)  
Constant light  
Films used: 35EA Hole Punched, 35EA120, 35DG Hole Punched, 35DG120, 20BH Hole Punched, 20BH120  
Loose potatoes were assessed vs. packaged product. | Limiting factor on all films was the level of greening seen.  
The high MVTR MA films delayed the greening whilst not encouraging the level of sprouting seen on the standard microperforated film.  
The chilled temperature regime delayed the greening, sprouting and rots seen on the same potatoes held under ambient conditions.  
Amcor 20BH120 had the least amount of greening and sprouting found than any other packaging trialled.  
Using Amcor 20BH120 (high MVTR MA) extended the shelf life by at least 3 days, under these conditions. | |
| 5a March 2010 – Albert Bartletts | To trial King Edwards in Amcor 20BH120 vs. standard film to determine the packaging which gave the best performance. | King Edward  
Ambient temperature (18-20°C)  
Constant light  
Films used: 35EA Hole Punched, vs. 20BH120 film. | Limiting factor on the current film was the level of greening seen.  
The high MVTR MA films delayed the greening whilst not encouraging the level of sprouting seen on the standard film.  
There was some black heart seen on the trial which needs to be investigated in more detail.  
Using Amcor 20BH120 (high MVTR MA) extended the shelf life by at least 3-4 days, under these conditions. | |
<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Experiment Description</th>
<th>Findings</th>
</tr>
</thead>
</table>
| 5b Apr 2010 | Greenvale        | To trial King Edwards in Amcor 20BH120 vs. standard film to determine the packaging which gave the best performance. In this trial two lighting regimes were used. | - King Edward  
- Ambient temperature (18-20°C)  
- Lighting regimes: Constant vs. covered at night.  
- Films used: 35EA Hole Punched, vs. 20BH120 film.  
- Limiting factor on the current film was the level of greening seen.  
- The high MVTR MA films delayed the greening seen on the standard film.  
- There was some black heart seen on the trial which needs to be investigated in more detail.  
- Covering the potatoes under card for periods did delay the greening seen on the current packaging.  
- Using Amcor 20BH120 (high MVTR MA) delayed the greening found; however, due to the black heart issue the shelf life extension could not be quantified. |
| 6a Jan 2010 | Albert Bartletts | To trial a variety of packaging on Maris Piper potatoes to determine the packaging which gave the best performance. | - Maris Piper  
- Ambient temperature (18-20°C)  
- Constant light  
- Films used: 35EA Hole Punched, 35EA120, 35DG Hole Punched, 35DG120, 20BH Hole Punched, 20BH120.  
- Limiting factor on standard microperforated film was the level of sprouting seen. The limiting factor on all the other films was the level of greening seen.  
- The high MVTR MA films delayed the greening whilst not encouraging the level of sprouting seen on the standard microperforated film.  
- Amcor 20BH120 had the least amount of greening and sprouting found than any other packaging trialled.  
- Using Amcor 20BH120 (high MVTR MA) extended the shelf life by at least 3 days, under these conditions. |
| 6b Feb 2010 | Greenvale        | To trial a variety of packaging for Maris Piper potatoes to determine the packaging which gave the best performance. | - Maris Piper  
- Ambient temperature (18-20°C)  
- Constant light  
- Films used: 35EA Hole Punched, 35EA120, 35DG Hole Punched, 35DG120, 20BH Hole Punched, 20BH120  
- Loose potatoes were assessed vs. packaged product.  
- Limiting factor on all films was the level of sprouting seen.  
- The high MVTR MA films delayed both the sprouting and the greening whilst not having the rots seen on the standard microperforated film.  
- The film permeability gave a slightly over modified atmosphere for this product held under these conditions.  
- Amcor 20BH120 and 35DG120 had the least amount of greening and sprouting found than any other packaging trialled.  
- Using Amcor 20BH120 and 35DG120 (high MVTR MA) extended the shelf life by at least 4 days, under these conditions. |
| Week 7 | February 2010 - Greenvale | To trial a variety of packaging for Maris Piper potatoes to determine the packaging which gave the best performance. | Maris Piper  
- Semi-chilled temperature (10-12°C)  
- Constant light  
- Films used: 35EA Hole Punched, 35EA120, 35DG Hole Punched, 35DG120, 20BH Hole Punched, 20BH120  
Loose potatoes were assessed vs. packaged product. | Limiting factor on all films was the level of sprouting seen.  
The high MVTR MA films delayed both the sprouting and the greening and gave a brighter appearance.  
The chilled temperature regime delayed the greening, sprouting and rots seen on the same potatoes held under ambient conditions.  
Amcor 20BH120 and 35DG120 had the least amount of greening and sprouting found than any other packaging trialled.  
Using Amcor 20BH120 and 35DG120 (high MVTR MA) extended the shelf life by at least 4 days, under these conditions. |
|---|---|---|---|
| Week 8 | June 2010 - Greenvale | To look into the issue of black heart seen on previous trials. | Maris Piper  
- Ambient temperature (18-20°C)  
- Constant light  
- Films used: 35EA Hole Punched, 35EA120, 35EA190, 20BH Hole Punched, 20BH120, 20BH190. | Limiting factor on the current film was the level of greening seen, on 35EA120 and 35EA190 it was the level of rots and moulds.  
The MA films delayed the greening seen on the standard film.  
The black heart was worse in Amcor P-Plus 35EA120 than any other packaging type.  
The level of black heart looks to be linked to both the gas levels found and the level of moisture transfer through the film.  
Using Amcor 20BH190 (high MVTR MA) did not make the black heart any worse than seen on hole punched packaging. |
| Week 9 | Albert Bartletts | To establish whether greening can be influenced by varying the print coverage. | Saxon, King Edwards and Charlotte.  
- Ambient temperature (18-20°C)  
- Films used: Standard coverage and 100% print coverage. | An increase in shelf life was achieved on all varieties.  
Saxon – An extra 3 days shelf life.  
King Edwards – An extra 3 days shelf life.  
Charlotte – An extra 2 days shelf life. |
4.4 Conclusions and recommendations

From the work conducted, it appeared that the most suitable film for maincrop potatoes was Amcor 20BH microperforated film (120 and 190). This film delayed the greening and sprouting whilst not encouraging the incidence of rots and moulds.

The shelf life extension seen on the trials was between three and four days, but it should be remembered that this was under trial conditions. It would need to be confirmed in the commercial supply chain under practical conditions. Although the 20BH material showed improvements compared to the conventional packaging, the effects on black heart need to be fully understood as this condition was identified during the trials. But the results would indicate the depletion of oxygen in the pack has the overriding effect.

When a crop that is susceptible to rots and moulds is to be packed, the most suitable film choice would be the 20BH hole punched material, as this would allow moisture from within the pack to escape to the external atmosphere more efficiently than any other packaging type tested. A 100% print coverage on the face of the retail packaging would reduce greening and extend shelf life.

The ideal solution, therefore, would be to print the Amcor 20BH and perforate (either microperforated or hole punched), dependent on the crop to be packed. This would allow the optimised film to be utilised throughout the year. Amcor is working with leading potato packers to progress the trials to the commercial level.

The results suggest several additional findings:

- Storing potatoes in chilled conditions, in the supply chain, as against ambient storage increased shelf life by one to two days.
- The process of covering the potatoes at night delayed the level of greening occurring on the potatoes, and this should be reinforced throughout the distribution chain.
- The lighting used around the potato display in-store should be reduced as much as possible. Three stores were tested for light intensity, where the readings ranged from 850 to 1250 lux, showing that there is potential for lighting levels to be reduced.
5.0 An investigation into UV barrier films

5.1 Background
The main issues with greening of potatoes are market appearance and potential toxicity. Green colouration is caused by chlorophyll synthesis, which is not in itself harmful when consumed. However, this green colouration acts as a marker for the formation of glycoalkaloids. Glycoalkaloids are a group of toxins of which solanine and chaconine are naturally present in potatoes. The production of these toxins will occur without exposure to light, but production is increased in its presence. Potatoes with levels of glycoalkaloids exceeding 200mg/kg are toxic to humans and cause gastrointestinal irritation.

There is conflicting information relating to the effect of ultraviolet (UV) light on the production of glycoalkaloids and little information linking UV and greening.

A trial was undertaken at Campden BRI to determine whether a PE UV barrier film, as compared to the standard PE film used for the majority of potatoes, could inhibit greening of main crop potatoes and hence in-store waste of potatoes.

5.2 Methodology
The trial was an investigation into the ability of UV barrier films to prevent greening. It was run until destruction, determined by the assessment of appearance taken throughout the trial.

Class 1, 2.5 kg bags of UK crop King Edward potatoes were the only variety used in this trial, as they are the most susceptible to greening. They were delivered direct to Campden BRI from the packer.

5.2.1 Film / packaging used
The control film used for this trial was standard Amcor hole punched PE. The trial film was Amcor hole punched UV barrier film. Twenty replicates were used for each treatment. It was estimated that less than 10% of the UV emitted by the lights in the storage area used for the trials was allowed through the Amcor UV barrier film.

5.2.2 Shelf life / storage
Running from 25 June to 1 July, Table 7 shows the conditions that were replicated at Campden BRI. It was accepted that precise replication of normal conditions was not possible. However, given that there is a large variability across stores / homes nationally, the most likely conditions were chosen.

<table>
<thead>
<tr>
<th>Days in set conditions</th>
<th>Conditions</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 0 to day 3</td>
<td>Subdued lighting, 8 to 10°C</td>
<td>This was to replicate the period of time that potatoes would spend in the distribution chain. Warehouses are often dimly lit to reduce exposure to light levels which will reduce the quality of products. Potatoes will be stored in chilled conditions.</td>
</tr>
<tr>
<td>Day 3 until destruction</td>
<td>Full (bright) lighting, 20°C</td>
<td>This was to replicate in-store conditions. These were chosen as worst case scenario; a large store which opens 24 hours a day, therefore the lights are on 24h (in-store the strip and spot lights are sometimes pointed at potatoes).</td>
</tr>
</tbody>
</table>

At the start of the trial two packs from each treatment were opened and a temperature and humidity recorder placed inside in order to record the conditions in-pack throughout the trial. Readings from these were taken daily (a continuous readout was not possible with these devices) and the results averaged for each treatment.

5.2.3 Light levels
Light levels (lux) were measured daily throughout the trial. Samples were placed onto shelves and not stacked, in order to expose them as much as possible to lighting (see Figure 18). Both control and UV barrier packs were stacked on a high, middle and lower shelf.

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29 UV light is electromagnetic radiation with a wavelength in the range 10 nm to 400 nm, shorter than that of visible light, which is 400 nm to 700 nm. UV light is naturally found in sunlight. Fluorescent lamps such as those found in supermarkets emit a small amount of UV light.
5.2.4 Shelf life assessments

Appearance
Throughout the trial, assessments were made of overall appearance, rots and moulds and greening. Samples were scored using the system applied in Section 3: overall appearance was scored on a scale spanning from 'very poor' (1) to 'excellent' (5); and rots and moulds and greening were scored between 1 and 5, as shown below. It was not possible to count the number of green potatoes so the percentage affected was estimated. The greening coverage and intensity of greening were also taken into account and noted where applicable.

1 - 100% of potatoes affected
2 - 75% of potatoes affected
3 - 50% of potatoes affected
4 - 25% of potatoes affected
5 - Very slight / none present

Assessment of sprouting was also carried out daily and the length of sprouts in mm recorded. Once the scores for the samples dropped below 3 the samples were deemed no longer acceptable (point of destruction).

Photographs were taken daily to provide as much consistency as possible. However, these did not always pick up the extent of greening. Where possible, all assessments were completed by the same person in order to reduce any error due to differences in opinions. On several occasions throughout the trial multiple assessors were used.

Total glycoalkaloid analysis
Total glycoalkaloid levels of the potatoes packed in control and UV barrier packaging film were measured at the end of trial in order to determine if they were below 200mg/kg. This is the level at which the potato becomes
Reducing supply chain and consumer potato waste

toxic (20mg/100g was stated by Dale et al in 1998 as being the level at which potatoes become unsuitable for human consumption\(^3\)).

Campden test method TES-AC-391 'HPLC determination of glycoalkaloids in potato products' was used. This involved analysis of the peel from three tubers (1 large, 1 medium and 1 small). These were weighed before removing and measuring the peel so that the total glycoalkaloid content could be estimated for the whole potato. Analysis was carried out on the peel because the majority of the glycoalkaloid content will be in the peel where the exposure to light is greatest.

5g of peel was blended in 30ml of methanol for 2 minutes, and then filtered. This filtrate was made up to 50ml with methanol. 5ml of this filtrate was added to 13ml water. The mixture was then applied to a Sep-Pak C18 cartridge, which was washed with 5ml of 40% methanol. The cartridge was eluted with 15ml methanol, evaporated to dryness, and then dissolved in 2ml methanol. 20μl was injected onto the HPLC system with UV detection set at 280nm. Calibration standards of solanine were run along with the samples. The standards ranged from 1 to 50ml. From this a calibration curve was plotted and the solanine concentration read directly from the curve.

Total glycoalkaloid content is made up of solanine and chaconine in a ratio of 1:3. Therefore, the solanine concentrations were multiplied by 3 to estimate the chaconine concentrations. The concentrations of these two compounds were then added together to obtain a value for total glycoalkaloid content in the peel. Using the tuber weights this value was used to estimate the content in the whole potatoes.

**Weight loss**

Samples of each variety were weighed at the beginning and end of the trial to determine any weight loss.

### 5.3 Results

**Storage conditions**

The light levels on days 0 to 3 ranged from 330 to 400 lux. Temperature and humidity over these three days ranged from 8.8 to 13.6°C and 95 to 98% respectively. The light levels were then increased from day 3 until the end of the trial, ranging from 1,020 to 1,980 lux. The temperature was also increased for the remainder of the trial to 20°C. When the temperature was increased the humidity within the packs appeared to drop. The control bags ranged from 69% to 77% relative humidity and in the UV barrier bags ranged from 75% to 97.5%. This drop in humidity was most likely due to a reduction in condensation in the bags at these increased temperatures.

**Appearance assessments**

On receipt, samples were scored at 4.5 due to some mechanical damage on the potatoes. Further reductions in scores throughout the trial were due to the level of greening that was noted on the samples. Potatoes stored under both treatments deteriorated at a similar rate, as shown in Figure 19. Five days after packing some signs of mould were noted on samples from both treatments. These were isolated to only a couple of potatoes in both incidences, and were on the ends where there had been mechanical damage.

Sprouting levels at the end of the trial were 1mm on 20% of potatoes from both treatments. It was noted that a small number of potatoes in both treatments were at the stage of 'eyes open' on receipt. Sprouts of up to 1mm where not noted until day 7.

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On the day of receipt some samples showed isolated spots of greening. These samples were not marked down as this would have occurred as the potato grew or during storage. Where present, this was marked onto the bags so that it was not then noted as greening during the trial. As shown in Figure 20, on day 3 the samples started to develop a green tinge. This was on approximately 15% of the control samples and slightly less on the samples packed in the UV barrier film. These treatments were scored the same because the potatoes in the UV barrier film were a slightly darker green than those in the control film (see Figure 21).
By day 4, 50% of the potatoes had green colouration. On day 6, 75% of the potatoes for both treatments were affected by greening. Figures 22 show examples of samples stored on the middle shelves.

**Figures 22:** Potatoes on day 6. Samples in left image were stored in control film, potatoes in the image on the right are potatoes stored in UV barrier film

**Total glycoalkaloid levels analysis**

The difference in the total glycoalkaloid levels found within the samples was attributed to natural variation and sample size. Toxin levels were above 200mg/kg in the peel of potatoes packed in the UV barrier film. When these levels were made up to estimate the levels throughout the tuber they were significantly below 200mg/kg (Figure 23).
Weight loss
The percentage weight loss for samples was similar, with potatoes packed in the control film losing 3.47% and those packed in the UV barrier film losing 3.84% (Figure 24).

Figure 23: Total glycoalkaloid content of samples from UV trial

![Graph showing total glycoalkaloid content of samples from UV trial.]

Weight loss
The percentage weight loss for samples was similar, with potatoes packed in the control film losing 3.47% and those packed in the UV barrier film losing 3.84% (Figure 24).

Figure 24: Percentage weight loss of potatoes from start to end of trial

![Graph showing percentage weight loss of potatoes from start to end of trial.]  

5.4 Conclusion
The results from this trial indicate that UV barrier film did not inhibit greening, so was not beneficial for increasing the shelf life of the potatoes. Potatoes packed in UV barrier film deteriorated at the same rate as those packed in standard retail packaging. Assessment scores for overall appearance, sprouting, rot / moulds and greening showed no difference between the two packaging formats. Total glycoalkaloid levels found within the samples were attributed to natural variation and sample size.
6.0 In-store training

6.1 Aims and objectives
Building on the findings from earlier parts of the project, and the experience from the project team, this part of the project aimed to improve the handling and storage of loose and pre-packed potatoes in the retail environment. A key aspect of the project was to identify good practice and disseminate guidelines for storage and handling of potatoes to prevent waste in the supply chain, and indirectly, in the home. With careless handling and poor storage conditions, potatoes can rapidly deteriorate. Indeed, once one potato is affected, the others around can also quickly spoil. Training to familiarise staff with approaches to preventing damage, recognising deterioration and understanding how to deal with defects, can be highly effective.

Improvements in potato handling were delivered by Albert Bartlett’s with the co-operation of Sainsbury’s and the Potato Council.

6.1.1 Staff training
Staff training was delivered to Sainsbury’s employees responsible for retailing fresh produce in stores in Scotland. Staff training events targeted 600 of these staff members over 2010-11. For example, Sainsbury’s store staff from Scotland were hosted at Bartlett’s on 23rd and 24th February for a training day on produce. Bartletts’ delivered messages on storage and handling of potatoes at retail stores as part of presentations during the event. It is intended that this material will then be included in equivalent Sainsbury’s training days for the rest of the UK, which each cover different regions.

Sainsbury’s has also held ‘Masterclasses’ for its fresh produce staff. These are two-hour sessions covering a range of topics relating to fresh potatoes. Box 1 shows an example of the format and content the events.

Box 1: Example of format for potato Masterclass

<table>
<thead>
<tr>
<th>22nd October 1100 – 1300: 2 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong> 5mins</td>
</tr>
<tr>
<td>Potatoes at Sainsbury’s 10mins</td>
</tr>
<tr>
<td><strong>Market share, value / volume, growth, brand tiering</strong></td>
</tr>
<tr>
<td><strong>Varieties, categories, fresh, organics v conventional, frozen, chilled, snacks</strong></td>
</tr>
<tr>
<td>What’s a potato? Plant biology and social history 5 mins</td>
</tr>
<tr>
<td>UK Potato production 20mins</td>
</tr>
<tr>
<td><strong>Yearly crop cycle, agronomy, new and maincrop, storage, impact of storage on quality and sugars</strong></td>
</tr>
<tr>
<td><strong>Common crop problems, greening, sprouting, bruising</strong></td>
</tr>
<tr>
<td><strong>Plant protection and testing for residues</strong></td>
</tr>
<tr>
<td><strong>Organic potatoes, need for Imports</strong></td>
</tr>
<tr>
<td><strong>Environmental issues, climate change</strong></td>
</tr>
<tr>
<td>Potato Varieties 25 mins</td>
</tr>
<tr>
<td><strong>Characteristics and functionality</strong></td>
</tr>
<tr>
<td><strong>Large display of contrasting varieties</strong></td>
</tr>
<tr>
<td><strong>Brief introduction to a 3-4 of these</strong></td>
</tr>
<tr>
<td>– breeding, history, particular traits etc heritage, fingerlings, phurejas, resistance</td>
</tr>
<tr>
<td><strong>Sampling 3 different varieties – introduction to waxy v floury</strong></td>
</tr>
<tr>
<td><strong>Explanation of dry matter, Ranking on scale taste / texture</strong></td>
</tr>
<tr>
<td><strong>Choosing the right potato for different processes:</strong></td>
</tr>
<tr>
<td>cooked samples ranked on scale taste / texture</td>
</tr>
<tr>
<td>Potato Nutrition 5 mins</td>
</tr>
<tr>
<td><strong>Nutritional value of potatoes, impact of storage, cooking</strong></td>
</tr>
<tr>
<td>Legal health claims</td>
</tr>
</tbody>
</table>
Consumer trends
Potato Council research - Insights into the current market
Consumer behaviour and consumption trends
Share of carbohydrate consumption, life stages insight

Growing appeal
Modernising the appeal for younger consumers
Emerging trends and new cuisines

Masterclass Demonstration

6.1.2 Poster
A poster was developed to deliver information on the best way to handle potatoes to all store staff, as shown in Figure 25 below. It communicates messages around handling and storage in a simple but effective way, and is available from WRAP without branding so that any retailer can use it.

Figure 25: Potato handling poster for supermarket staff
6.1.3 Newsletter
Sainsbury's produces an internally circulated newsletter called "On the Grapevine", for staff in fresh produce departments. It targets 4,000 staff and is circulated every three weeks, with three to four editions featuring potatoes over 2010/11.

6.1.4 Produce champions
Sainsbury's are establishing a regional network of "Produce Champions", as part of an internal initiative called Project Greengrocer. Those agreeing to be selected will be charged with dissemination of information to store staff involved with fresh produce. They will be encouraged to pass on relevant information on new developments, which can be communicated to these "Champions" on a regular and continuing basis.

6.2 Recommendations
There are opportunities for retailers to optimise the quality of fresh potatoes sold to customers, which would then allow for a longer shelf life at home. For example, the avoidance of bruising in the retail environment prevents the onset of defects that may encourage premature disposal in the home.

This can be achieved without the need for significant investment, by engendering a culture of careful handling in-store through targeted communication using, for example, staff training, posters and newsletters.
Appendix A: Potato Resource Map

Source: Fruit and Vegetable Resource Maps, WRAP, June 2011

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**Resource map: Potatoes**

- **Main causes of field loss and waste**
  1. Harvest damage - affected by weather - e.g. if too dry than more bruising for some varieties (e.g. 2009).
  2. Small potatoes left in the field.

- **Main causes of grading, storing and packing loss and waste**
  1. Storage losses due to water loss, defects and skin damage.
  2. During promotions grading is less critical as the amount downgraded reduces, but waste increases if promotions work too well as grading of product can occur before tubers are fully conditioned (warmed from cold store).
  3. Production covered by planting programmes and selling plans but can flex time in store to deal with forecast inaccuracy.
  4. Retailers short lead times is a reflection of inability to forecast.

- **Main causes of retail waste**
  2. Customer damage in store on loose potatoes.
  3. Poor forecasting can increase waste and energy use (storage).
  4. Weather affects consumption not waste e.g. uplift of 2-50% for new potatoes in good weather and baker can increase by 20-100% in cold weather.
  5. Longer lead times = less wasted resources but no effect on waste.

---

**Destination and uses of less and waste**

Different markets: primary wholesale and processed markets.
- Animal feed 5-11% (more in July/August).
- Alternate markets: composting (field waste - ploughed back and may have beneficial effect on soil condition).
- Physical waste: minimal (9% landfill/ENF from suppliers) but prevalent at retailer level.

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Footnotes: % ranges given in the loss stream were sourced from six principal potato suppliers which make up ca. 60% market share.
* no data on to or other losses associated with imported tubers.
Appendix B: Profile of Survey Population

Note: the following data are based on those respondents who purchased fresh potatoes (19.7% of the total survey population did not buy fresh potatoes and were therefore screened out of the survey).

### Table B1: Age and gender distribution of survey population (Base: 1691)

<table>
<thead>
<tr>
<th>Age</th>
<th>Male</th>
<th>% of Total</th>
<th>Female</th>
<th>% of Total</th>
<th>Total</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-24</td>
<td>62</td>
<td>3.7</td>
<td>77</td>
<td>4.6</td>
<td>139</td>
<td>8.2</td>
</tr>
<tr>
<td>25-44</td>
<td>219</td>
<td>13.0</td>
<td>266</td>
<td>15.7</td>
<td>485</td>
<td>28.7</td>
</tr>
<tr>
<td>45-64</td>
<td>232</td>
<td>13.7</td>
<td>334</td>
<td>19.8</td>
<td>566</td>
<td>33.5</td>
</tr>
<tr>
<td>65+</td>
<td>214</td>
<td>12.7</td>
<td>287</td>
<td>17.0</td>
<td>501</td>
<td>29.6</td>
</tr>
<tr>
<td>Total</td>
<td>727</td>
<td>43.0</td>
<td>964</td>
<td>57.0</td>
<td>1691</td>
<td>100</td>
</tr>
</tbody>
</table>

### Table B2: Socio economic distribution of survey population (Base: 1691)

<table>
<thead>
<tr>
<th>Social Grade</th>
<th>A/B/C1</th>
<th>% of Total</th>
<th>C2/D/E</th>
<th>% of Total</th>
<th>Total</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Count</td>
<td>% of Total</td>
<td>Count</td>
<td>% of Total</td>
<td>Count</td>
<td>% of Total</td>
</tr>
<tr>
<td>16-24</td>
<td>46</td>
<td>2.7</td>
<td>93</td>
<td>5.5</td>
<td>139</td>
<td>8.2</td>
</tr>
<tr>
<td>25-44</td>
<td>260</td>
<td>15.4</td>
<td>225</td>
<td>13.3</td>
<td>485</td>
<td>28.7</td>
</tr>
<tr>
<td>45-64</td>
<td>287</td>
<td>17.0</td>
<td>279</td>
<td>16.5</td>
<td>566</td>
<td>33.5</td>
</tr>
<tr>
<td>65+</td>
<td>193</td>
<td>11.4</td>
<td>308</td>
<td>18.2</td>
<td>501</td>
<td>29.6</td>
</tr>
<tr>
<td>Total</td>
<td>786</td>
<td>46.5</td>
<td>905</td>
<td>53.5</td>
<td>1691</td>
<td>100</td>
</tr>
</tbody>
</table>

Socio economic groups are based on the head of the household or chief income earner and are defined as follows:

A: Higher managerial, administrative or professional
B: Intermediate managerial, administrative or professional
C1: Supervisory or clerical, and junior managerial, administrative or professional
C2: Skilled manual workers
D: Semi and unskilled manual workers
E: All those entirely dependent on the state long term, through sickness, unemployment, old age or other reasons.

### Table B3: Working status of survey population (Base: 1691)

<table>
<thead>
<tr>
<th>Working Status</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full time</td>
<td>577</td>
<td>34.1</td>
</tr>
<tr>
<td>Part time (8-29)</td>
<td>205</td>
<td>12.1</td>
</tr>
<tr>
<td>Part time (&lt;8)</td>
<td>9</td>
<td>0.5</td>
</tr>
<tr>
<td>Retired</td>
<td>594</td>
<td>35.1</td>
</tr>
<tr>
<td>At School</td>
<td>5</td>
<td>0.3</td>
</tr>
<tr>
<td>Higher Education</td>
<td>41</td>
<td>2.4</td>
</tr>
<tr>
<td>Unemployed</td>
<td>90</td>
<td>5.3</td>
</tr>
<tr>
<td>Not seeking</td>
<td>170</td>
<td>10.1</td>
</tr>
<tr>
<td>Total</td>
<td>1691</td>
<td>100</td>
</tr>
</tbody>
</table>
### Table B4: Number in household of survey population (Base: 1691)

<table>
<thead>
<tr>
<th>Number in Household</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>406</td>
<td>24.0</td>
</tr>
<tr>
<td>2</td>
<td>607</td>
<td>35.9</td>
</tr>
<tr>
<td>3</td>
<td>272</td>
<td>16.1</td>
</tr>
<tr>
<td>4</td>
<td>258</td>
<td>15.3</td>
</tr>
<tr>
<td>5+</td>
<td>148</td>
<td>8.8</td>
</tr>
<tr>
<td>Total</td>
<td>1691</td>
<td>100</td>
</tr>
</tbody>
</table>

### Table B5: Lifestage distribution of survey population (Base: 1691)

<table>
<thead>
<tr>
<th>Life Stage</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 45 Pre-family/no family</td>
<td>286</td>
<td>16.9</td>
</tr>
<tr>
<td>Any Age with children</td>
<td>442</td>
<td>26.1</td>
</tr>
<tr>
<td>45-64 with no children</td>
<td>463</td>
<td>27.4</td>
</tr>
<tr>
<td>65+ Retired no children</td>
<td>500</td>
<td>29.6</td>
</tr>
<tr>
<td>Total</td>
<td>1691</td>
<td>100.0</td>
</tr>
</tbody>
</table>

### Table B6: Regional distribution of survey population (Base: 1691)

<table>
<thead>
<tr>
<th>Region</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>North East</td>
<td>70</td>
<td>4.1</td>
</tr>
<tr>
<td>North West</td>
<td>185</td>
<td>10.9</td>
</tr>
<tr>
<td>Yorks and Humber</td>
<td>140</td>
<td>8.3</td>
</tr>
<tr>
<td>East Midlands</td>
<td>118</td>
<td>7</td>
</tr>
<tr>
<td>West Midlands</td>
<td>153</td>
<td>9</td>
</tr>
<tr>
<td>South West</td>
<td>150</td>
<td>8.9</td>
</tr>
<tr>
<td>East of England</td>
<td>161</td>
<td>9.5</td>
</tr>
<tr>
<td>London</td>
<td>204</td>
<td>12.1</td>
</tr>
<tr>
<td>South East</td>
<td>224</td>
<td>13.2</td>
</tr>
<tr>
<td>Wales</td>
<td>87</td>
<td>5.1</td>
</tr>
<tr>
<td>Scotland</td>
<td>144</td>
<td>8.5</td>
</tr>
<tr>
<td>NI</td>
<td>55</td>
<td>3.3</td>
</tr>
<tr>
<td>Total</td>
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<td>100</td>
</tr>
</tbody>
</table>