This research reviews the use of pallet collation films in the UK grocery market and identifies opportunities to optimise their usage in the UK food and drinks sector.
WRAP’s vision is a world without waste, where resources are used sustainably.

We work with businesses, individuals, and communities to help them reap the benefits of reducing waste, developing sustainable products and using resources in an efficient way.

Find out more at www.wrap.org.uk

Written by: Peter Davey & Greg Wood

While we have tried to make sure this report is accurate, we cannot accept responsibility or be held legally responsible for any loss or damage arising out of or in connection with this information being inaccurate, incomplete or misleading. This material is copyrighted. You can copy it free of charge as long as the material is accurate and not used in a misleading context. You must identify the source of the material and acknowledge our copyright. You must not use material to endorse or suggest we have endorsed a commercial product or service. For more details please see our terms and conditions on our website at www.wrap.org.uk
Executive summary

In 2012, as part of its efforts to support Courtauld Commitment 2 signatories and other supply chain stakeholders, WRAP commissioned a project to identify, develop and communicate good practice in the use of resources and materials in collating palletised loads using filmic materials throughout the UK grocery supply chain.

The main objectives of the study were to identify opportunities to:

- Reduce the equivalent carbon dioxide (CO₂e) impact of packaging through use of less and/or lower gauge stretch and shrink wrap for pallet load consolidation (where appropriate);
- Reduce stretch and shrink wrap waste arising in the supply chain through use of less and/or lower gauge stretch and shrink wrap for pallet load consolidation (where appropriate); and
- Reduce product wastage through improved pallet load consolidation and therefore reduce damage in the supply chain.

This report presents the findings of the study along with discussion around current film and wrapping technology together with commentary explaining these opportunities and discussing some barriers to uptake.

Film use in the food and drinks sector is circa 77,000 tonnes per annum. Around 60% or 46,000 tonnes of wrap are used in manual wrapping operations with 31,000 tonnes or 40% used in semi or fully automated wrapping machines.

By collating and extrapolating data from a variety of sources, the UK market size has been estimated and industry segmentation for palletisation stretch film shown in the table below:

<table>
<thead>
<tr>
<th>Market sector</th>
<th>% of the market</th>
<th>Tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>41</td>
<td>57,400</td>
</tr>
<tr>
<td>Beverages</td>
<td>14</td>
<td>19,600</td>
</tr>
<tr>
<td>Healthcare</td>
<td>5</td>
<td>7,000</td>
</tr>
<tr>
<td>Cosmetics</td>
<td>4</td>
<td>5,600</td>
</tr>
<tr>
<td>Other Consumer</td>
<td>17</td>
<td>23,800</td>
</tr>
<tr>
<td>Industrial/Bulk</td>
<td>20</td>
<td>28,000</td>
</tr>
<tr>
<td><strong>UK Stretch film Market</strong></td>
<td><strong>100%</strong></td>
<td><strong>140,000</strong></td>
</tr>
</tbody>
</table>

Source: Innventia Edge Research 2012

Developments in resins and film production methods offer the opportunity to light weight film and reduce waste. These developments include:

- Light-weighting of films;
- Pre-stretched films;
- Coreless films for manual wrapping applications;
- Various solutions to the issue of “necking-down”;
- Net films.

Following a detailed review of the research outputs it is possible to reach a number of important conclusions as to the current use of palletisation films:

- Stretch film is the primary material used in pallet stabilisation in the UK, representing >96% of the market;
- The UK market for stretch film in pallet stabilisation is estimated at 140,000 tonnes annually, of which 77,000 tonnes are used by the food and drinks sector;
- Manual wrapping accounts for around 60% of use, the remaining 40% is split between semi and fully automatic wrapping machines;
The manufacture and supply of film is highly fragmented and although the market is consolidating this situation is likely to pertain for the foreseeable future; Whilst some stability issues are experienced by retailers and wholesalers, the stability of pallets wrapped in the UK food and drinks sector is generally perceived to be good; Technological advances have resulted in new films which offer the opportunity for considerable light weighting of film whilst maintaining strength; Wrapping patterns and applied film thickness should be reviewed regularly in order to take advantage of latest thinking and advances in film quality and application techniques; Anecdotal evidence from study respondents indicated that industry initiatives, such as primary and secondary packaging light-weighting and adoption of retail ready packaging, had acted as drivers for increased pallet film use.

Importantly, it has been found that there are a number of undeveloped opportunities to effect significant reductions in the weight of film used by greater adoption of new films and by optimising the use of films through regular reviews and better management of wrapping operations. The main recommendations of the study are:

- Before changing suppliers, films or load collation technologies, comprehensive plant trials should be undertaken;
- When buying film, the recommended metrics to use are ‘cost per applied metre’ or ‘cost per pallet wrapped’ (cost per tonne divided by number of pallets wrapped per tonne of film);
- Operators should determine their wrapping specifications in consultation with subject experts such as film suppliers (and machine providers where applicable);
- Operators should consider migrating to new, lighter weight films, whilst maintaining load restraining characteristics;
- Semi-automatic wrapping operations should employ pre-stretched films rather than standard films to optimise film yield;
- Manual wrapping operations should consider migrating to coreless films in order to minimise waste arising from spent cores and film ‘ends’;
- Operators should consider using stabilisation adhesives as an alternative or to reduce film use;
- Operators should regularly, at least annually, review their operations to ensure the optimum materials and methods are employed; and
- Manual wrapping operations need to be closely managed to ensure consistency and minimise film waste.

Film usage needs to be monitored by the company on a regular basis, at least annually, and alternative options reviewed/considered and trialled if appropriate.

This study has identified that there is significant scope to optimise the use of film pallet wrapping in the UK food and drink sector. Increasing the uptake of modern stretch films along with improved wrapping methods present a real opportunity to reduce the tonnage of wrapping film used by substantial amounts.

The following table outlines the potential size of this opportunity for the >96% of the food and drink sector utilising stretch films, given three film technology improvement scenarios and differing rates of adoption.
<table>
<thead>
<tr>
<th>Wrapping application</th>
<th>Scenario</th>
<th>Current usage (Tonnes)</th>
<th>UK food &amp; drinks sector Film saving (in tonnes) assuming an additional:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>10% Adoption</td>
</tr>
<tr>
<td>Manual wrapping (60% of total stretch film usage in Food &amp; Drink – 77Kt)</td>
<td>Light-weighting of film by 50%</td>
<td>46,200</td>
<td>2,310</td>
</tr>
<tr>
<td></td>
<td>Increased use of coreless film</td>
<td>4,620</td>
<td>462</td>
</tr>
<tr>
<td></td>
<td>2,310 tonnes of wasted film on reel ends</td>
<td>2,310</td>
<td>231</td>
</tr>
<tr>
<td>Machine wrapping – semi and fully automatic – 40% of stretch film usage in Food &amp; Drink – 77Kt</td>
<td>Increased use of pre-stretch film</td>
<td>30,800</td>
<td>1,386</td>
</tr>
<tr>
<td>Alternative pallet stabilisation technology</td>
<td>Increased use of adhesives</td>
<td>77,000</td>
<td>7,700</td>
</tr>
</tbody>
</table>

This table presents the potential size of the opportunity given adoption of pallet adhesive stabilisation technology displacing stretch film given differing rates of adoption.
Contents

1.0 Introduction .................................................................................................................. 11
  1.1 Background ................................................................................................................ 11
  1.2 Optimising Stretch film use in the UK food & drinks sector ..................................... 11
2.0 Aims & Objectives ........................................................................................................ 11
  2.1 Aims ............................................................................................................................ 11
  2.2 Objectives .................................................................................................................. 11
3.0 Methodology .................................................................................................................. 12
  3.1 Stage 1: Identify current practice ............................................................................... 12
    3.1.1 Onsite reviews .................................................................................................... 12
    3.1.2 SME telephone interviews ............................................................................... 13
    3.1.3 Stage 2: Develop best practice ......................................................................... 13
    3.1.4 Stage 3: Communicate good practice ................................................................. 13
    3.1.5 Good practice guidance and case studies ......................................................... 13
    3.1.6 Development of an online tool ......................................................................... 14
4.0 Pallet collation film in the UK Food & Drinks sector .................................................. 14
5.0 The key types of palletisation film ................................................................................. 15
  5.1 What is stretch film? .................................................................................................. 15
  5.2 Manufacturing processes ......................................................................................... 15
    5.2.1 Blown film ......................................................................................................... 15
    5.2.2 Cast film ........................................................................................................... 16
  5.3 Differences between Blown and Cast stretch films .................................................. 16
  5.4 Alternative pallet collation films ............................................................................. 17
6.0 The UK market for palletisation films ........................................................................... 17
  6.1 Stretch film usage in the UK food & drink sector ...................................................... 17
7.0 Film wrapping methods ............................................................................................... 18
  7.1 Manual wrapping ....................................................................................................... 18
  7.2 Semi -automated wrapping machines ..................................................................... 19
  7.3 Fully automated wrapping machines ...................................................................... 19
  7.4 Pre-stretch capability ............................................................................................... 20
  7.5 Load types ................................................................................................................ 20
    7.5.1 “A” Profile load ................................................................................................ 21
    7.5.2 “B” Profile load ................................................................................................ 21
    7.5.3 “C” Profile load ................................................................................................ 21
8.0 Materials and Technology Review .............................................................................. 22
  8.1 Latest Trends in Stretch film production .................................................................... 22
    8.1.1 Light-weighting of stretch films ...................................................................... 22
    8.1.2 Introduction of pre-stretch films ....................................................................... 22
    8.1.3 Barriers to adoption of pre-stretched film ......................................................... 22
    8.1.4 Introduction of coreless films .......................................................................... 22
    8.1.5 Barriers to adoption of coreless film ................................................................. 23
    The UK manually applied film market is currently dominated by extended core film which offers ease of handling using no additional tools ........................................ 23
    8.1.6 Innovative film improvements to reduce neck-down ....................................... 23
    8.1.7 Net films ........................................................................................................... 24
    8.1.8 Barriers to adoption of net film ...................................................................... 24
  8.2 Alternatives to stretch film use .................................................................................. 24
    8.2.1 Barriers to adoption of stabilisation adhesives ............................................... 25
9.0 Research Findings ......................................................................................................... 25
  9.1 Pallet Stability is generally good ............................................................................... 25
Optimisation of pallet wrapping film use

9.2 Main issues with inbound palletised loads ................................................. 26
  9.2.1 Pallet damage ......................................................................................... 26
  9.2.2 Poor scanning ......................................................................................... 26
  9.2.3 Film tails ................................................................................................. 26
  9.2.4 Film waste in wrapping operations ......................................................... 27
9.3 Drivers of increased film use ........................................................................ 27
9.4 Procurement ................................................................................................ 28
9.5 Film thickness .............................................................................................. 28
9.6 Wrapping Patterns ......................................................................................... 29
  9.6.1 Sub optimal wrapping .............................................................................. 29
9.7 Importance of regularly reviewing film use .................................................... 29
  9.7.1 Transit testing ......................................................................................... 30
9.8 Product damage levels .................................................................................. 30
9.9 Managing Performance .................................................................................. 30

10.0 Conclusions & Recommendations ................................................................ 30
  10.1 Film reduction opportunities ...................................................................... 32
  10.2 Film reduction opportunities from operational improvements ................. 32
  10.3 Recommendations ..................................................................................... 32

Appendix 1 ........................................................................................................... 34
Appendix 2: Case studies ....................................................................................... 35

Table 1 Differences between blown and cast stretch films ................................ 16
Table 2 The UK market for palletisation stretch film 2011 .................................... 17
Table 3 UK Food & Drink Sector Hand and Machine film usage ........................... 18
Table 4 Wrapping method summary ................................................................... 21
Table 5 Stretch film reduction through film technology improvement opportunities 31
Table 6 Stretch film reduction opportunity through the adoption of palletisation adhesive technology ................................................................. 31

Figure 1: Project stages and key activities ........................................................... 12
Figure 2: UK Grocery distribution in 1960 .......................................................... 14
Figure 3: Schematic of blown film manufacturing .............................................. 15
Figure 4: Schematic of cast film manufacturing .................................................. 16
Figure 5: Semi and Fully automatic wrapping machines ..................................... 19
Figure 6: Automated Pre-stretching mechanism .................................................. 20
Figure 7: Wrapping machine Industry standard load profiles .............................. 20
Figure 8: Examples of reusable handles for coreless stretch film ....................... 23
Figure 9: Main issues with inbound palletised loads .......................................... 26
Figure 10: Waste film remaining on cores ............................................................ 27
Glossary & Abbreviations

- **A-Load Pallet**: Industry standards designate a palletised load with a uniform shape and no sharp edges or protrusions as an "A-load".

- **Automatic wrappers**: Generally a variant of a semi-automatic system. Automatic wrappers include a conveyor system to automatically load the wrapping machine and automatic systems to apply, seal, and cut the film.

- **B-Load Pallet**: Industry standards designate a palletised load with a somewhat irregular shape and a moderate degree of sharp edges or protrusions as a "B-load".

- **Blown/Cast Stretch Wrap Films**: Refers to the two types of extrusion processes used to manufacture stretch film. Cast films offer greater clarity and tear resistance, whereas blown films offer greater puncture resistance. Process improvements in both extruding methods have narrowed the quality differences.

- **C-Load Pallet**: Industry standards designate a palletised with a highly irregular shape and many sharp edges or protrusions as a "C-load".

- **Courtauld Commitment**: The Courtauld Commitment is a responsibility deal aimed at improving resource efficiency and reducing the carbon and wider environmental impact of the grocery retail sector. Phase 2 follows the original Courtauld Commitment (Phase 1), launched in 2005. It moves away from solely weight-based targets and aims to achieve more sustainable use of resources over the entire lifecycle of products, throughout the whole supply chain. Measurement of the Courtauld Commitment 2 targets is from January 2010 to December 2012 against a 2009 baseline. The three targets are:
  - Packaging – to reduce the weight, increase recycling rates and increase the recycled content of all grocery packaging, as appropriate. Through these measures the aim is to reduce the carbon impact of this grocery packaging by 10%.
  - Household food and drink waste – to reduce UK household food and drink waste by 4%.
  - Supply chain product and packaging waste – to reduce traditional grocery product and packaging waste in the grocery supply chain by 5% - including both solid and liquid wastes.

- **Clarity**: Blown films tend to be hazier than cast films, allowing less light to pass through. High clarity films give wrapped loads an attractive appearance, but can sometimes interfere with scanning processes, due to increased light reflection.

- **Cling**: The characteristic of a pallet stretch wrap film to cling to it (but not the products it is wrapping). Tackifiers are added to film during the manufacturing process to enhance a film’s cling.

- **CO₂e**: The carbon equivalent emissions

- **Film memory**: If certain plastics (take for instance PTFE) is subjected to stresses below its yield point then it may be subjected to permanent deformation. This deformation will induce certain strains throughout the material. If the plastic is heated up, these strains tend to relax which allows the plastic to return to its original shape. This is often referred to as "plastic memory".

- **Gauge/Micron**: The two most common units of measure to express the thickness of stretch film. Common film thicknesses are 7, 8, 11, 12,13,14,15,17,20,23 micron (μ).

- **Hand Stretch Wrap Films**: Films that are delivered to a pallet manually, typically with a hand held stretch wrapping tool.

- **LLPDE**: Linear Low Density Polyethylene.

- **LPDE**: Low Density Polyethylene.

- **Machine Stretch Wrap Films**: Films that are delivered to a pallet through a fully automatic or semi-automatic stretch film machine.

- **Memory**: The elastic characteristic of pallet stretch wrap that makes it want to return to its pre-stretched length. Stretch film memory exerts holding force on a wrapped load, keeping items packed tightly together for secure shipment.

- **Metallocene**: A chemical compound found in some stretch film resin formulations. Metallocene gives film superior clarity and puncture resistance characteristics.
**Neckdown/necking:** As a film is stretched and loses a percentage of its original roll width, the film is necking down. Different films produce differing degrees of neckdown when stretched. The more a film necks down, the more film is required to provide full coverage around the pallet.

**One Side Cling Stretch Film:** Film with tackifier predominantly on one side only. One side cling films are effective for applications where wrapped pallets are tightly packed in a truck, rail car, or warehouse storage. When the smooth side of the film faces out, wrapped loads can be easily moved in and out of position without tearing the film or sticking to and damaging adjacent pallets.

**Pre-stretch:** Some automatic stretch film machines pre-stretch film before delivering it to the pallet. Most pre-stretch systems, especially powered pre-stretch units, significantly increase film stretch, thereby reducing film usage and improving film performance. Pre-stretching film also reduces "neckdown".

**RDC – Regional Distribution Centre:** Large storage and distribution facilities operated by retailers to serve their stores in a particular geographic region.

**Roping:** Gathering or bunching stretch film as it is being applied to the pallet, allowing the film to perform a banding/strapping function. Roping can be done with a hand stretch wrapping tool or on automatic stretch wrappers equipped with a roping attachment.

**Semi-Automatic Wrappers:**
- **Turntable Wrappers:** The load to be wrapped sits on a turntable which spins the load relative to the film roll, which is housed in a carriage which can move up and down a fixed "mast". Stretch is achieved by rotating the load at a faster rate than the film is fed.
- **Orbital Wrappers:** The film is housed in a carriage on a vertical ring, the load is fed horizontally through the eye of the rotating ring, applying film to the load. A variation of an orbital stretch wrapper is a horizontal ring system, in which the load remains still while a horizontal ring is rotated around the load and moves up and down vertically relative to the load, similar to a rotary arm stretch wrapper.
- **Rotary Arm Wrappers:** In this system, the load remains still while a rotating arm turns around it wrapping the load. This system is used for light loads or for speeds which would otherwise cause the load to topple due to high rotation speeds.

**Tackifiers:** Chemicals added to a film during the manufacturing process to increase its stickiness, or cling.

**Tailing:** When a film unravels from a wrapped pallet, it is tailing. Tailing compromises load integrity and creates safety hazards in shipment and handling. Tailing can be caused by poor quality film and/or environmental and application factors.

**Tear Resistance:** The ability of a stretch film to resist tearing, frequently measured using the Elmendorf Test.

**Zippering:** The tendency of a film to tear or puncture to propagate, or widen. Excessive zippering, a characteristic common in low quality films, greatly compromises load integrity.
Acknowledgements

In addition to the many companies and individuals who contributed anonymously to the study, we would particularly like to thank the following companies and individuals for their contributions:

Alex Begley, BPI Films
Allen Cottis, DHL
Andrew Chinnery, Megaplast
Arno Melchior, Reckitt Benckiser
Barry Turner, PAFA
Bernard Sellars, Lindum Packaging
Bob Stevenson, Axicon
Cathy Marston, Booker Wholesale
Colin Barker, Aetnagroup UK
Craig Armstrong, AB InBev
David Barkway, Lock n Pop products
David Walkinshaw, Aetnagroup UK
Deborah Clarke, AG Barr
Denise Pieri, Tesco
Einar Olgeirsson, Youngs Seafoods
Graham Humphries, Eurofilms
Greg Sellars, Lindum Packaging
James Smith, Shepley Spring
Jim Quigley, Inver House Distillers
Joanne Clark, J.S.Sainsbury
Kevin Holmes, Premier Foods
Martin Palmer, Eurofilms
Nick Smith, Eurofilms
Paddy McCartney, Aetnagroup UK
Paul Hughes, AB InBev
Paul Mc Guinness, Reckitt Benckiser
Phil O’Neill, Hazledene Foods UK
Phil Wooldridge, Silver Spoon
Richard Bailey, Booker Wholesale
Russell Houchin, DHL
Steve Green, QV Foods
1.0 Introduction

1.1 Background

The Courtauld Commitment is a voluntary producer responsibility agreement aimed at improving resource efficiency and reducing the carbon and wider environmental impacts of the grocery retail sector. By the end of Phase 1 (2005–2009), WRAP calculated that 1.2 million tonnes of food and packaging waste had been prevented, consisting of 670,000 tonnes of food waste and 520,000 tonnes of packaging across the UK. This equated to approximately £1.8 billion worth of food and packaging waste avoidance and circa 3.3 million tonnes of CO$_2$ equivalent emissions.

Courtauld Commitment Phase 2 (CC2) sets further challenging targets. In particular, CC2 moves away from solely weight-based targets and aims to achieve more sustainable use of resources over the entire lifecycle of products, throughout the whole supply chain. At the launch of CC2 in March 2010, 29 major retailers and brand owners had pledged their commitment, rising to 53 participants by August 2011. The targets for this phase of the agreement are:

- Packaging Target: Reduce the carbon impact of packaging by 10% through weight reduction, increased recycling and increased recycled content;
- Household Food and Drink Waste Target: To reduce household food and drink wastes by 4%;
- Supply chain product and packaging waste: To reduce traditional grocery product and packaging waste in the grocery supply chain by 5% - including both solid and liquid wastes.

1.2 Optimising Stretch film use in the UK food & drinks sector

In 2012 as part of its efforts to support CC2 signatories and other supply chain stakeholders to prevent waste in the supply chain, WRAP commissioned a program of study to identify, develop and communicate good practice in the use of resources and materials in collating palletised loads throughout the grocery supply chain. It is worth noting that many of the lessons learned in the food and drinks sector can be applied across other industry sectors thereby further increasing the potential of this research to reduce packaging waste.

2.0 Aims & Objectives

2.1 Aims

The main aims of the study were to:

Identify, develop, and communicate good practice in the use of resources and materials in collating palletised loads throughout the UK grocery supply chain.

2.2 Objectives

The main objectives of the study were to:

- Reduce the CO$_2$ e impact of packaging through use of less and/or lower gauge stretch and shrink wrap for pallet load consolidation (where appropriate);
- Reduce stretch and shrink wrap waste arising in the supply chain through use of less and/or lower gauge stretch and shrink wrap for pallet load consolidation (where appropriate);
- Reduce product wastage through improved pallet load consolidation and therefore reduce damage in the supply chain.
3.0 Methodology

The study program was carried out in three distinct stages:

**Figure 1: Project stages and key activities**

<table>
<thead>
<tr>
<th>Project stages</th>
<th>Stage 1: Identify current practice</th>
<th>Stage 2: Develop good practice</th>
<th>Stage 3: Communicate good practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities</td>
<td>- Onsite reviews</td>
<td>- Evaluation of data and observations from onsite reviews</td>
<td>- Preparation of good practice guidance documents</td>
</tr>
<tr>
<td></td>
<td>- SME telephone interviews</td>
<td>- Literature and technology review</td>
<td>- Specification and development of online tool</td>
</tr>
</tbody>
</table>

3.1 Stage 1: Identify current practice

In order to identify and document current load collation practices in the UK grocery market it was important to survey a representative sample of companies operating in the sector. This part of the study was carried out in two parts as detailed below.

3.1.1 Onsite reviews

The core element of this study was a series of onsite reviews. The objective of these onsite reviews was to establish the current methods of load collation and usage levels of pallet stretch and shrink wrap within 10 large scale organisations operating within and representative of the UK grocery supply chain.

In order to ensure consistency in the approach applied across the different organisations, an onsite review method and information collection template was defined, detailing the data to be collected, questions to be asked, etc. The approach utilised a combination of visual observations, anecdotal evidence gathered through targeted questions, and structured data collection and analysis. Elements of the approach included:

- Reviewing organisations’ existing collation specifications;
- Comparing if/how actual practice conforms to these; and
- The onsite reviews established for each product category handled by the organisation:
  - Materials used (material gauges, total weights/annual material usage).
  - The process (manual, auto or semi auto) and any preparation steps (e.g. pre-stretching).
  - Quantity of material used per product characteristics (weight, palletisation details, secondary packaging types, etc).
  - Current damage levels.
  - Annual dispatch volumes.

The ten companies selected for the onsite reviews were mostly drawn from the 53 Courtauld Commitment signatories. The companies covered key product categories such as drinks, ambient foods, and ambient, chilled, and frozen temperature regimes. The surveyed organisations also covered a wide range of product weights and handling characteristics in order to derive the maximum benefit for the study. High street retailers generally utilise returnable transit stillages such as roll cages and tote bins for store distribution and therefore a large scale grocery wholesaler was included in the study as it dispatches product on pallets. Two large grocery retailers were also visited in order to determine damage levels on inbound loads and gain an appreciation of the general quality of pallet collation in the UK grocery market.
Operations within these organisations were reviewed at all stages of the supply chain, i.e.: internal work in progress; loads dispatched to distribution centres; loads to retailers Regional Distribution Centres (RDCs); and RDCs to stores.

3.1.2 SME telephone interviews
The 10 companies selected for onsite reviews were major national or multi-national businesses. However, SME food manufacturers are collectively significant users of stretch palletisation materials. Therefore, it was decided to engage with 20 SMEs operating in the UK grocery sector to establish current working practices in relation to load collation in these lower throughput operations. Primary engagement was via a series of telephone interviews, although this was supplemented with on-site visits and face to face interviews as necessary. In tandem with this activity it was decided to interview the leading wrapping equipment manufacturer together with a leading film manufacturer and a number of film suppliers to gather their insights.

This activity enabled the scale of the opportunities identified by the study to be extrapolated and assisted the project team in formulating guidance materials which are relevant and easily understood by SMEs.

3.1.3 Stage 2: Develop best practice
The data and information gathered during Stage 1, supplemented by additional information gathered from desk-based activities, was used to develop and describe best practice for load collation.

The data collected from onsite reviews was also interrogated to identify trends, variances, etc. In parallel to this, an international literature and technology review was undertaken to identify existing and emerging techniques, materials, and machinery which could further improve performance. This was supplemented by interviews with UK material and machinery suppliers to ascertain latest technological developments and thinking.

From these information strands, best practice scenarios were developed which describe good practice in terms of process and materials usage, etc.

The practices of the ten onsite review participants and of the SME companies interviewed were compared against the best practice scenarios. This was used to determine the scale of opportunities available in the UK pallet collation film market and the total UK grocery supply chain opportunity. The potential Carbon savings were also calculated using the WRAP carbon methodology.

3.1.4 Stage 3: Communicate good practice
The objective of this stage of the project was to prepare and deliver materials which communicate and encourage the adoption of good practice. There were three main elements to this activity:

- Preparation of this report detailing the study, conclusions and recommendations;
- Preparation of five good practice case studies; and
- Development of a simple online tool to guide users and specifiers to select appropriate materials and processes.

3.1.5 Good practice guidance and case studies
The results of the study were used to generate good practice guidance, with a series of five carefully selected case studies to clearly illustrate how good practice can be implemented and what benefits (financial and environmental) can be realised.

It should be noted that good practice will mean different things to different companies, depending on their specific policies and approaches to capital expenditure, pay-back times, etc. In preparing the case studies and best practice, attention was given to identifying improvements that can be realised through different material reduction strategies.
3.1.6 Development of an online tool
The objective of the online tool is to guide users and specifiers to review a series of material reduction options and quantify their current usage and potential material and carbon reduction opportunities achievable from adopting different material reduction options.

4.0 Pallet collation film in the UK Food & Drinks sector

Today the UK has a highly developed grocery supply chain. However, in the post-war years the sector was highly fragmented. Manufacturers considered independent retailers to be “outlets” where their products were sold to the public in a classic “manufacturing push” supply chain. Supply to stores was mainly via van sales and products were loose loaded onto vans from local or regional warehouses. See Figure 2.

The 1950s and 1960s saw the decline of small independent stores in favour of supermarket retailing. Additionally, the rapid retail consolidation seen throughout the 1960s and 1970s ensured that retailers soon became the dominant force in the UK grocery supply chain. This process quickened with the move to centralised retail distribution networks in the early 1980s. The UK grocery sector had become a “consumer pull” supply chain. Suppliers no longer delivered small quantities direct to store but instead delivered large loads to regional distribution warehouses which in turn collated store specific, mixed product loads based on consumer demand for onward delivery to retail stores.

Figure 2: UK Grocery distribution in 1960

Source: PDMC Limited archive

These changes in distribution lead to the development of large scale RDCs fitted with high level pallet racking. This in turn increased the need to stabilise palletised loads to cope with longer distribution routes and increase stability of pallets stored at high level.

Stretch film was introduced as a pallet stabilisation material from the late 1970s. It offered a simple to use and cost effective solution to the pallet stability and quickly achieved widespread adoption across the food and drink sector and indeed many other industry sectors. Use of stretch film to stabilise palletised loads is now a well-established industry practice. Wrapping a palletised load has the following benefits:

- Helps to stabilise the load;
- Provides a dust cover to protect the product packaging;
- Provides a barrier to moisture; and
- Acts as a visual aid to deterring and recognising theft or tampering.
5.0 The key types of palletisation film

A variety of film formats are used in pallet stabilisation applications. However, the principal material used is stretch film which offers the lowest wrap weight of all the filmic palletisation solutions and is therefore the most cost effective solution.

5.1 What is stretch film?
The most common stretch wrap material is linear low-density polyethylene or (LLDPE), which is produced by copolymerization of ethylene with alpha-olefins, the most common of which are butene, hexene and octene. The use of higher alpha-olefins (hexene or octene) gives rise to enhanced stretch film characteristics. LLDPE has high tensile strength and high impact and puncture resistance. It is very flexible and elongates under stress. It can be used to make thinner films, with better environmental stress cracking resistance. LLDPE films can be stretched up to 500%, but in practice 300% is likely to be the most such films are stretched on automatic or semi-automated wrapping machines.

Stretch film works by utilising film memory characteristics under pre-stretch conditions which, when using the correct lay on force secures the load to the pallet without damaging the stock. The tension in the film holds the load consolidated and in place. Any product movement is resisted as the film tries to elongate further. As stretching the film on application has already increased the tensile strength this retaining force is heightened.

As films are stretched their thickness decreases and their tensile strength increases. Therefore pre-stretched films are not only stronger than standard films but increase yield or coverage.

5.2 Manufacturing processes
There are two methods of producing stretch films:

5.2.1 Blown film
Beads of resin are fed through a heated extruder with a circular die. The heated resin is forced through the die and then blown out vertically into a bubble. As this bubble is inflated and the film drawn off the extruded plastic forms an inflated thin filmic cylinder is cooled by the surrounding air. The resulting tube is slit and wound up into reels of stretch film.

---

**Figure 3:** Schematic of blown film manufacturing
5.2.2 Cast film
The casting process is similar to the blown method, with beads of resin being fed into a heated extruder and then forced through a narrow slotted die. The 'sheet' of film from the die is then fed along a rolling path that has been cooled, this solidifies the film. It is then brought through the final stages of production and made into large rolls.

Figure 4: Schematic of cast film manufacturing

5.3 Differences between Blown and Cast stretch films
The table below shows the main differences in characteristics between stretch films manufactured by the blown and cast methods:

Table 1 Differences between blown and cast stretch films

<table>
<thead>
<tr>
<th>Film Properties</th>
<th>Blown Stretch Film</th>
<th>Cast Stretch film</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Load Retention:</td>
<td>Excellent holding properties in use. Will not stretch much further after application</td>
<td>Will stretch after application so palletised loads can be less stable.</td>
</tr>
<tr>
<td>2. Film Memory:</td>
<td>Good material memory to return to original size</td>
<td>Less material memory than blown film</td>
</tr>
<tr>
<td>3. Film Yield:</td>
<td>Has increased stretch and can wrap more pallets with the same length of film</td>
<td>Not as much stretch as blown film</td>
</tr>
<tr>
<td>4. Puncture Resistance:</td>
<td>Manufacturing process creates greater resistance to breakage of film</td>
<td>Tearing can occur when film is highly stressed.</td>
</tr>
<tr>
<td>5. Cling of the Film:</td>
<td>1 sided cling, Useful for higher load retention and prevents pallets sticking together in transit</td>
<td>Clings on both sides which can make pallets stick together</td>
</tr>
<tr>
<td>6. Visual Clarity:</td>
<td>Not fully clear which can make barcode scanning harder. However film has lower gloss thus reducing reflections</td>
<td>Perfectly clear, makes reading and scanning in warehouse light easy, but a higher gloss makes reflections which can reduce barcode read rates.</td>
</tr>
<tr>
<td>7. Noise in use</td>
<td>Can be very loud when releasing from the roll</td>
<td>Very quiet when unwound from the stretch roll</td>
</tr>
</tbody>
</table>
5.4 Alternative pallet collation films

Other film formats include:

- Shrink film
- Shrink hoods
- Stretch hoods

These formats are normally used to stabilise particularly heavy and unstable load types such as may be found in the building industry. The study found that in the UK food and drink sector shrink films and hoods are only used by some drinks suppliers to wrap pallets of glass and polyethylene terephthalate (PET) bottles which tend to be heavy and unstable. However, other drinks suppliers interviewed in the course of the study had considered and discounted the use of shrink films as uneconomic for such loads. Shrink films and hoods are made with heavy gauge film which is machine applied to a palletised load and heat treated to “shrink” it onto, and thereby stabilise, the load. One drinks manufacturer stated that shrink hoods used 1Kg of film per pallet and although the resulting load was very stable it was possible to achieve the same level of stability using far less stretch film. Because of the cost of shrink films and the capital investment required in wrapping machines and their on-going energy requirements this is the most expensive method of load stabilisation currently in use.

The study noted the rapid decline of shrink film usage in pallet collation. Shrink film use in Western Europe is in steady decline at around -2% p.a. in favour of other methods of wrapping. Currently shrink film accounts for less than 10% of all film supplied in the UK (>14,000 tonnes p.a.) and less than 4% of UK grocery sector film usage.

6.0 The UK market for palletisation films

The European market for pallet stretch film is circa 1,400,000 tonnes according to recent research carried out by Applied Market Information Ltd. Within Europe the UK has the fourth largest market for palletisation stretch film after the former Soviet countries, Italy and Germany.

Calculating the UK market size is problematic as the manufacture and supply of film is a highly fragmented activity and even the leading UK distributors supply a small percentage of UK market requirements. By collating data from a variety of sources the market size and industry segmentation for palletisation stretch film has been estimated as shown in Table 2.

<table>
<thead>
<tr>
<th>Market sector</th>
<th>% of the market</th>
<th>Tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>41</td>
<td>57,400</td>
</tr>
<tr>
<td>Beverages</td>
<td>14</td>
<td>19,600</td>
</tr>
<tr>
<td>Healthcare</td>
<td>5</td>
<td>7,000</td>
</tr>
<tr>
<td>Cosmetics</td>
<td>4</td>
<td>5,600</td>
</tr>
<tr>
<td>Other Consumer</td>
<td>17</td>
<td>23,800</td>
</tr>
<tr>
<td>Industrial/Bulk</td>
<td>20</td>
<td>28,000</td>
</tr>
<tr>
<td><strong>UK Stretch film Market</strong></td>
<td><strong>100%</strong></td>
<td><strong>140,000</strong></td>
</tr>
</tbody>
</table>

Source: Innventia Edge Research 2012

6.1 Stretch film usage in the UK food & drink sector

From Table 1 it can be seen that stretch film use in the UK food and drinks sector combined is around 77,000 tonnes p.a. The market is mature and stretch film usage in pallet stabilisation could be expected to see low future growth rates in line with overall market growth of around 2% p.a. However, the European film market has seen a drive towards packaging reduction in response to initiatives such as CC2. Light-weighting of films and other technological advances are likely to reduce the tonnage figure over time. Film manufacturers interviewed for the study reported film tonnages
sold falling whilst sales remained stable as users switched from basic films to lighter, more technologically advanced formats.

In the UK market manual wrapping accounts for around 60% of stretch film use with semi-automated and fully automated machine wrapping accounting for the balance. Therefore the tonnages of film used in hand and machine wrapping in the UK food and drink sectors can be estimated as shown in Table 3.

<table>
<thead>
<tr>
<th>UK Food &amp; Drink sector stretch film use</th>
<th>Hand wrap usage 60%</th>
<th>Machine wrap usage 40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>77,000 tonnes p.a.</td>
<td>46,200 tonnes</td>
<td>30,800 tonnes</td>
</tr>
</tbody>
</table>

7.0 Film wrapping methods

There are three methods of using stretch film to wrap a palletised load: Manual or manual wrapping, semi-automated wrapping, or fully automated wrapping.

7.1 Manual wrapping

Manual wrapping of palletised loads is the predominant method in use in the UK, accounting for circa 60% of all film use.

Manual wrapping stretch film requires an operator to attach the film to the load and then proceed to unwind the stretch film from the film roll as he/she circles the load. The operator must also apply tension to the film to ensure enough wrapping force is applied to contain and unitize the load. As the stretch film rolls have to be manipulated by the operator, the size and weight of the film rolls must be limited for ease of use. Thus hand wrap is typically narrow in width (400mm) and also shorter in length to limit the weight of the roll. The UK market favours extended core film where the core extends beyond the reel of film in order to provide handles for the operator. In Europe the situation is reversed with users preferring standard core film used with separate applicators or reusable handles.

The great benefit of manual wrapping is the level of flexibility this method gives to enable a skilled operator to securely wrap a load. This is particularly true of unstable or irregular shaped loads which can be very hard to wrap by machine. However, if the operator is poorly trained or inexperienced poor wrapping can result. Due to variability of tension applied to the wrap due to factors such as the energy levels of the operative, manual wrapping is far less consistent than either semi-automated or fully automated wrapping.

Manual wrapping operations are generally carried out in warehouse or dispatch area away from the production line and thus a backlog of pallets to wrap is unlikely to interrupt production. Study participants reported that they usually wrapped pallets in a particular area. However, the flexibility of this solution enables wrapping to be carried out virtually anywhere on site.

One of the drawbacks of manual wrapping is the health and safety aspect of what is a repetitive manual task involving pulling, bending, and stretching. Whilst semi-automated wrapping requires a level of bending and manual handling, manual film wrapping requires the operator to tension the film by applying pressure against the load to be wrapped. This activity has the potential to cause strain injuries and care is required.
7.2 Semi-automated wrapping machines

Semi-automatic pallet wrapping machines are typically used in medium to high use applications. During the study it was noted that semi-automated wrapping machines were in use with a variety of food and drinks manufacturers ranging from large scale operators to SMEs. Although every case is different, operations wrapping more than 100 pallets per day should consider using a semi-automated wrapping machine as operational savings should ensure a quick payback on the capital investment at this level of usage.

Semi-automatic wrappers do not require much floor space and offer a good degree of flexibility as wrapping patterns can be easily adjusted if required thus facilitating the handling of various load types. The machines surveyed were all located in dispatch or warehouse areas away from the production line. This is important as the wrapping operation should not hold up production in the event of a breakdown.

Semi-automatic machines generally require the operator to place the pallet to be wrapped on a turntable powered by the wrapping machine. An operator then attaches the loose end of the film to the load. The machine then performs a pre-set wrapping pattern to wrap the load before the operator secures the tail end of the film and removes the wrapped load from the turntable using some form of pallet truck.

7.3 Fully automated wrapping machines

There are a wide variety of fully automated wrapping machines on the market. However, these are intended for use in high volume throughput environments. Automated wrapping machines are usually situated “in-line” at the end of the manufacturing process and can require a large amount of space. Indeed, lack of suitable space within the manufacturing facility can be an issue when considering this option. Fully automated wrappers usually control the whole wrapping process of introducing the pallet to the wrapping machine, usually by conveyor, wrapping the load, securing the loose end of the film, and dispatching the unitised load to its next destination in the plant.

Some machines spin the load to wrap it while others revolve around the load to be wrapped and the pallet remains stationary. The wrapper can also pre-stretch the film as it is applied to the load to ensure extra stability.

The capital cost of this type of machine is high and only the largest manufacturers taking part in the study had made this level of investment.
It was also noted during on site reviews that several participants have disused automated wrappers on site rendered obsolete by changes in pack configuration or other operational changes. Fully automated machines trade flexibility for speed of operation and are best suited to operations handling high volume of similar load types. However, the study found automated wrappers handling a wide variety of pack formats, including cardboard cartons, shrink collated PET bottles and heavy paper sacks.

7.4 Pre-stretch capability
Some machines can pre-tension the film as it is applied to give additional stability to the wrapped load. To do this the film passes between two rollers on the wrapping machine (primary and secondary) and a series of pinch rollers on the film carriage. The primary roller pulls film off of the film roll and into the film carriage at a controlled speed. Due to the difference in the diameter of the rollers and the ratio of the gearing driving the rollers, the secondary roller turns at a faster speed than the primary roller, so the film is stretched between the two. See Figure 6. However, with the advent of pre-stretched films standard wrapping machines can now provide the same benefits as more complicated wrappers by switching to use pre-stretched film in place of standard stretch film.

**Figure 6: Automated Pre-stretching mechanism**

Currently only around a third of fully auto and semi auto wrapping machines in the UK have a pre-stretching capability. Our research further indicated that the pre-stretching capability of many of these machines is likely to be poor due to lack of proper maintenance. To date there has been slow adoption of pre-stretched film and the machine suppliers interviewed in the study believe that migrating wrapping machine users to using pre-stretched stretch film offers a significant opportunity to rapid reduction in film use in the UK market.

7.5 Load types
The most suitable wrapping method for a particular load has to be based on a number of factors including the volume of pallets to be wrapped, labour costs and availability of capital. However the primary consideration has to be the load characteristics. The height, weight, and load stability have to be taken into account along with the regularity of the load and whether it has sharp edges or protrusions. The wrapping machine industry has developed standard profiles to categorise palletised loads into one of three groupings. See Figure 7:

**Figure 7: Wrapping machine Industry standard load profiles**
7.5.1 “A” Profile load
An A profile load is defined as a pallet load where the load footprint is the same size as the pallet, with a uniform shape and no protrusions is classed as an "A-Type load".

7.5.2 “B” Profile load
A B profile load is defined as a pallet load where the load footprint is different to the size of the pallet, maybe slightly in-bound. The load may also have an irregular shape.

7.5.3 “C” Profile load
A C profile load is defined as a pallet load where the load footprint is significantly different to the size of the pallet. The load may also have a highly irregular shape with many sharp edges or protrusions.

Table 4 details the favoured wrapping method for each of the three load types. From this it can be seen that manual wrapping is suitable for all load types at low levels of throughput whereas machine wrapping is best suited to wrapping larger volumes of more regular load types.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Manual wrapping</th>
<th>Semi-Automatic</th>
<th>Fully Automated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput</td>
<td>Limited by ability of labour to handle pallet throughput</td>
<td>Cost effective in most throughputs greater than 100 pallets per day</td>
<td>Requires large throughput to justify capital expenditure</td>
</tr>
<tr>
<td>Load profile A</td>
<td>Suitable</td>
<td>Suitable</td>
<td>Suitable</td>
</tr>
<tr>
<td>Load profile B</td>
<td>Suitable</td>
<td>Suitable</td>
<td>Suitable</td>
</tr>
<tr>
<td>Load profile C</td>
<td>Suitable</td>
<td>Not recommended</td>
<td>Not recommended</td>
</tr>
<tr>
<td>Flexibility – ability to wrap various load types quickly</td>
<td>Highly flexible</td>
<td>Flexible</td>
<td>Inflexible</td>
</tr>
<tr>
<td>Consistency of film application</td>
<td>Wrapping pattern dependant on operator - may be less consistent at end of day</td>
<td>High - operates on a preselected wrapping pattern</td>
<td>High - operates on a preselected wrapping pattern</td>
</tr>
<tr>
<td>Film economy</td>
<td>At operator discretion. Likely to apply excessive film in certain situations and can only apply limited tension to film</td>
<td>Operates to preselected pattern and can apply high tension to film resulting in greater economy</td>
<td>Operates to preselected pattern and can apply high tension to film resulting in greater economy</td>
</tr>
<tr>
<td>Health &amp; Safety</td>
<td>High Manual handling Risks</td>
<td>Low H&amp;S Risks</td>
<td>Low H&amp;S Risks</td>
</tr>
<tr>
<td>Film damage &amp; waste</td>
<td>High - due to operator error such as dropped and damaged reels and poor discipline in discarding part used reels</td>
<td>Low. Machine not subject to operator error and uses film to end of reel</td>
<td>Low. Machine not subject to operator error and uses film to end of reel</td>
</tr>
<tr>
<td>Capital expenditure</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Operational costs</td>
<td>Labour cost and on-going training required</td>
<td>On-going maintenance contracts &amp; energy costs</td>
<td>On-going maintenance contracts &amp; energy costs</td>
</tr>
</tbody>
</table>

Source: Innventia Edge Research 2012
8.0 Materials and Technology Review

Interviews were held with leading participants in the UK stretch film market; film manufacturers, distributors and wrapping equipment suppliers, to determine the latest technological trends in film production and wrapping equipment manufacture with a view to identifying current best practice.

8.1 Latest Trends in Stretch film production

Film suppliers interviewed in the course of this study were united in their view that film technology had advanced rapidly over the last five years and would continue to do so in future. Developments in resin compounds and manufacturing technology have enabled five important developments all of which have the capacity to reduce film usage:

- Light-weighting of films;
- Pre-stretched films;
- Coreless films for manual wrapping applications;
- Various solutions to the issue of “necking–down”; and
- Net films.

8.1.1 Light-weighting of stretch films

Advances in resin technology and manufacturing processes have enabled stretch films to be manufactured in a range of lighter gauges than was previously possible whilst retaining and in some cases increasing the mechanical strength of the film. New polyethylene resins developed using "Metalloocene" change the polyethylene chain structure resulting in a range of improved stretch films. Improvements include increased puncture resistance and clarity while blends offer balanced film properties.

Although light-weighting of film in this way is a good route to material reduction, light weighting of film can also be achieved by migrating to pre-stretched film; these also have greater strength making them more attractive to users.

8.1.2 Introduction of pre-stretch films

It has long been recognised that by stretching film its tensile strength is increased. Once film is stretched the film tries to return to its initial form. This is called the memory of the film. It is this film memory that helps differentiate pre-stretch film from other methods of unitizing. Pre-stretched film has strength added by stretching the material at the point of manufacture. The elasticity of the film is reduced at the same time which ensures that whilst the film secures the load it does not cause crushing or deformation issues.

A variety of semi-automatic and automatic wrapping machines are already available which can pre-stretch conventional films at the point of wrapping. Film manufacturers have introduced ranges of pre-stretched films for use in both automated and manual wrapping formats. These films are supplied pre-stretched typically to 150% or 250%.

Pre-stretched film products have high tensile strength and thin gauges due to the pre-stretching process thus reducing the material used by between 40-60% compared to conventional stretch films.

8.1.3 Barriers to adoption of pre-stretched film

Pre-stretched films currently account for only around 5% of the UK palletisation film market. Although this figure is growing rapidly it represents a major opportunity for further film reduction through more widespread adoption. The research identified three barriers to adoption of pre-stretched films:

- Relatively new concept
- Higher apparent price of Pre-stretched films – Greater film yield makes this film cost effective
- Presence of some inferior pre-stretched films creating negative perceptions.

8.1.4 Introduction of coreless films

Approximately 100 million plus rolls of hand stretch film are produced annually in Europe most of which are wound onto cardboard cores. The core becomes a waste component when the film has
been dispensed that not only adds cost to the product, but also slows down production and creates environmental issues with waste disposal after the product is used.

Due to advances in film production, rolls of film can now be produced without the traditional cardboard core. This innovation offers many advantages including, lower cost and major environmental benefits due to elimination of the cardboard core and elimination of wasted material on reel ends. The technology is currently only applied to manual wrapping films but it is hoped to extend this to machine rolls in the future.

Coreless film utilises reusable handles and eliminates the need for the cardboard core. Each cardboard core weighs around 250grams. The UK food and drinks sector uses around 46,200 tonnes of hand film per annum equating to 18.5m rolls of film. The maximum potential cardboard saving given adoption by the whole sector is therefore **4,620 tonnes**.

When using coreless film instead of the fixed cardboard core users are required to purchase reusable handles which are threaded through the centre of the film roll. Operatives then use the handle to apply the film, removing the handle when the film is expended. Previous attempts to remove cardboard cores have failed as film often shrank in width towards the end of the roll resulting in unacceptable levels of waste film. However, technological advances in film production have overcome this issue so the film can be used right to the end of the roll.

8.1.5 Barriers to adoption of coreless film
The UK manually applied film market is currently dominated by extended core film which offers ease of handling using no additional tools.

Despite doubling market share over the last two years coreless film is still not widely adopted in the UK or Europe, currently accounting for approx. 4% of the stretch film market. In the UK the most significant barrier to more widespread adoption is the need for an additional tool, and a health and safety concern with a number of the available reusable handle types. These concerns were said to be primarily due to sharp edges on fins designed to lock the handle into the film roll.

**Figure 8:** Examples of reusable handles for coreless stretch film

Coreless stretch film users report that although detachable handles are not expensive they are easily lost or damaged.

8.1.6 Innovative film improvements to reduce neck-down
As a film is stretched in length it also reduces in width. This is often described as “necking down”. Different films produce differing degrees of “neck down” when stretched. Increased tension toward the reel end increases “neck down” causing material binding at reel ends.
Operators tend to discard films when “neck down” causes binding even if there is still a significant amount of film left on the roll. Recent improvements in film manufacture have seen a variety of innovative solutions to this issue including rolling the edges of the film, lateral pre-stretching of the film, and tapering of the material width toward the reel end. Whilst these changes may seem insignificant our research shows that film left on spent cores can be as great as 5%, equivalent to 2,310 tonnes across the hand wrap market, and therefore represents a real opportunity to reduce film usage. Any steps to reduce “neck-down” have good potential to reduce film waste.

8.1.7 Net films
Net films are stretch films with pre-cut circular holes evenly spaced across and along the film web reducing material weight by approximately 30%.

Net films were originally developed in response to the specific problems of food manufacturers when wrapping recently produced products which were still hot and so caused condensation inside the pallet wrap. The regular perforations in the film enable free flow of air around the load and aid cooling whilst preventing the build-up of condensation.

As an additional benefit the pre-formed holes tend to line up with any sharp corners or protrusions on the load. This prevents the issue of puncturing and zipperng associated with standard films.

8.1.8 Barriers to adoption of net film
Although intended to have a limited application, net films provide the lightest weight of film per metre approximately 30% less material than equivalent thickness film and therefore have the potential in principle to reduce the use of stretch film by as much as 23,100 tonnes if adopted for more general food and drink products. However, the cost of net films is currently more than that of standard films. As net films are a relatively recent innovation it is felt that when there is more widespread adoption prices will move towards those of standard films.

Net films are unlikely to fully replace standard stretch films as they do not offer the same level of dust and moisture protection as solid film.

8.2 Alternatives to stretch film use
During the study alternatives to pallet stabilisation films were considered. One such alternative is stabilisation adhesives. Among a number of suppliers, the best known of these is “Lock n Pop”, a water-based adhesive with high shear but low tensile or fracture strength. This means that loads secured with this system are stable to lateral displacement but easy for operators to break when lifting cases from the load. Lock n Pop adhesive is water soluble, is 100% recyclable and virtually invisible. The quantity of adhesive required per pallet load varies according to substrate but is only a few grammes compared to 200 to 400 grammes of stretch film for a typical pallet load. “Lock n Pop” is applied in-line by cold spray application with a low energy requirement.

Other pallet stabilisation adhesives based on hot melt glue technology are also available on the market. Hot melt based pallet stabilisation adhesives perform in a similar way to “Lock n Pop”. However there are a number of differences; hot melt is visible on the surface of treated packs and uses around 20 - 30 grammes of adhesive per pallet. Hot melt glues are applied by heating the adhesive at the point of application and have a higher energy requirement than cold applied adhesives.

“Lock n Pop” seems to have become the generic term for all stabilisation adhesives and the operators surveyed in the study were not always aware of the differing systems.

Stabilisation adhesives are spray applied to loads at the palletisation stage of the dispatch process. Distributors of adhesives report that the capital cost of application equipment is around £7,000. Adhesives where technically appropriate are a cost effective and material efficient option compared to film. Payback on the capital equipment required is likely to be quick in most circumstances.

Adhesive manufacturers claim stabilisation adhesives are suitable for a wide range of load types including trays of cans, cardboard cartons, shrink collations and paper or plastic bags. The type of
adhesive, spraying pattern and quantity of adhesive needs to be carefully matched to substrate and load characteristics.

In some circumstances stabilisation adhesives can completely remove the need for stretch film wrapping of loads. More widespread adoption would provide significant material savings provided fit for purpose solutions are achievable.

8.2.1 Barriers to adoption of stabilisation adhesives
Stabilisation adhesives have been commercially available for the last 30 years and despite the obvious potential for replacing stretch film there has been not been a significant, widespread adoption of these systems to date.

They are most commonly observed and in shrink wrap or carton collations of canned and bottled beverages.

Barriers to more widespread adoption include:

- System best suited to high throughput lines;
- The ubiquitous status of film solutions;
- Perceived health and safety concerns over ‘non wrapped’ pallet loads in high bay warehousing; and
- A lack of industry standards.

Retailers surveyed for the study had mixed opinions concerning the use of stabilisation adhesives. Some were in favour of suppliers switching to adhesives thus reducing the amount of palletisation film retail RDCs had to handle and manage as waste.

Some retailer distributions centres are currently stretch wrapping the top layers of inbound pallets stabilised with adhesives before the pallets are racked in the warehouse. The potential for material reduction achievable through using stabilisation adhesives is such that even if suppliers had to apply a few wraps of film to meet retailer safety demands it would still yield significant packaging savings.

It is likely that stabilisation adhesive use will remain fragmented unless strong retailer initiatives push for full evaluation of the fitness for purpose of the various adhesive / substrate / product combinations and the creation of standards to create the opportunity for greater adoption of this material.

9.0 Research Findings

9.1 Pallet Stability is generally good
The retailer and wholesaler participants in the study were questioned as to the levels of unstable and collapsed pallets they encountered in their distribution networks and whether this was a serious issue. Their view was that the vast majority of goods inwards were received in a satisfactory condition from a wrapping and stability viewpoint.

Levels of damage due to poor wrapping or unstable palletisation were stated to be “very low” although it was not possible to obtain robust data to support this assertion as unstable loads were normally returned to the supplier immediately. On extremely rare occasions loads were received where several pallets had collapsed but these were linked to some extreme event during road transit rather than issues with how the pallets were wrapped. Goods shipped into the UK from overseas, and therefore subject to extended transit periods, were stated to be more prone to stability issues.

In order to maintain warehouse productivity, some retailers have instituted a penalty scheme to charge suppliers for the inconvenience of failed deliveries arising from poor palletisation. The aim of these penalties is to drive down instances of failed deliveries arising from poor palletisation. On a positive note all retailer and wholesaler study participants were working collaboratively with their suppliers to improve delivery standards and resolve issues on an on-going basis.
Retailers and wholesalers felt that stretch wrapping was the industry norm for pallet stabilisation although they also dealt with alternative formats such as stabilisation adhesives. The issue of disposing of waste stretch film was discussed and it is clear that this material is usually collected, baled, and sent off site for recycling. Whilst this activity costs money it is felt to be unavoidable and is partly offset by the recycling revenue.

9.2 Main issues with inbound palletised loads
The most common issues identified on receipt of goods were:

- Pallets received in poor condition;
- The serial shipping container code (SSCC) is an 18-digit number used to identify logistics units. The SSCC is often encoded in a barcode which may not scan; and
- Tails of loose film on pallets.

9.2.1 Pallet damage
Although most reputable suppliers use good quality pallets there is still a relatively high incidence of pallets received at retailer RDC’s with obvious damage such as loose planks or missing corner blocks. Such damage makes the whole load potentially unstable and dangerous to handle. Therefore, such loads are normally rejected at the point of receipt.

9.2.2 Poor scanning
A recent audit by Axion, a leading scanning technology provider identified that up to 34% of inbound goods in a particular retail RDC had scanning issues which either prevented or slowed the receipt of goods. The way stretch film is applied to the palletised load is a leading cause of such scanning issues.

The main stretch film requirements for successful scanning are:

- A clear film is preferable;
- There should not be any stress lines in the film in the area of the barcode. Stress lines are more common in pre-stretched films;
- The film must lie flat against the barcode;
- There shouldn’t be a gap between the film and the barcode.

The scanning audit also found that the number of wraps tends to be fewer in the centre section of the pallet. This is therefore the best location to scan outer case barcodes.

Figure 9: Main issues with inbound palletised loads

Source: DHL

9.2.3 Film tails
Lengths of loose film trailing from palletised loads are potentially dangerous in warehouse environments. The increase in automated storage facilities has prompted increased focus on this issue
as loads with tails are more likely to be rejected by the goods inwards scanning units which determine whether loads are safe to put-away.

The issue is mainly caused by operatives forgetting to secure the end of the film to the load after wrapping or due to the film working loose in transit. The solution is for operatives to ensure that film ends are securely tucked into the film layers and for machine wrapped pallets the film end should either be heat sealed to the load or stuck to the load using the natural cling of the film.

Using modern films it is also possible to use the films’ natural cling to secure the leading end of the film to the load somewhere near the mid-point of the load.

9.2.4 Film waste in wrapping operations
Semi-automated and fully automated wrapping machines offer the most consistent methods of pallet wrapping and there is little potential for film wastage. However, manual wrapping has greater potential for wasting film through mishandling damage and through operatives leaving residual film on “spent” cores. From observation and discussions with survey participants it is felt that this issue could account for up to 5% of film supplied, representing as much as 3,850 tonnes of wasted film in the food and beverage industry alone. Recycling companies were reported to be unwilling to accept cardboard cores containing some residual film thus further increasing the potential for material waste.

**Figure 10: Waste film remaining on cores**

![Waste film remaining on cores](image)

Source: Innventia Edge Research 2012

In order to tackle this issue operators have come up with innovative incentive schemes such as requiring operatives to write their initials on spent cores. In one such scheme a monthly prize is awarded to the operator with on average the lowest spent core weight. This simple scheme incentivises personnel to use film to the end of the core and ensures spent cores are recycled rather than going to waste. Whilst incentive schemes are useful aids to waste reduction in large scale operations they may not be as effective in small scale operations.

In general the best way to prevent film waste is through regular staff training to ensure efficient use of film and utilisation of the maximum amount of film from each core.

9.3 Drivers of increased film use
Manufacturing participants stated that a number of factors were actually causing them to use more film. These were primarily due to retailer demands for additional delivery formats other than "standard" 1200 x 1000mm pallets. The following main drivers were cited:
Some retailers specifying smaller “Euro” pallets 1200 x 800mm which result in a higher number of pallets for a given quantity of product and consequently more film usage;

- More widespread adoption of movable display units;
- Retail ready packaging formats weakening secondary packs and therefore requiring better stabilisation to maintain pallet load integrity;
- Restrictions on overall pallet height and loading for automated fulfilment centres. This increases film use as more pallets are required for a given volume of product and film use is greatest at the base and top layers of pallets; and
- Moves to lightweight secondary packaging.

9.4 Procurement

Respondents were questioned regarding their procurement of films and methodology for determining film specifications. The research indicates a very mixed situation with some companies taking a great interest in what film they purchase and its related cost whilst others pay insufficient regard to what they are actually buying and the yield it achieves.

Stretch film is often viewed as a consumable item and price per roll or pallet load is seen as the key factor in purchasing decisions. Buying in this way is not sensible given the fragmented nature of film supply and manufacturing and the different pricing structures of the industry players.

Although some stretch film is manufactured in the UK, most film used in the UK is manufactured in Europe with some imports coming from the Middle East and Asia. There is a wide variety of film specifications, core weights, and film lengths on the market making it extremely difficult for operators to compare one product with another. Some of the variable factors are shown below:

- Cored Vs. Coreless;
- Standard core or extended core;
- Weights of different cardboard cores;
- Width of film (400mm or 500mm) hand wrap only;
- Length of film on a core;
- Standard film Vs. pre-stretched; and
- Thickness of film.

The only true measures of film should be the thickness and the length of the film as it is applied to the pallet load, it is surprising that many of the companies surveyed purchase film by the roll, pallet, or tonne.

Once the correct thickness of film for a particular application has been determined film should ideally be purchased based on a **cost per metre**. This removes the temptation to include the weight of the cores and even the transit packaging (sometimes including the pallet) in the weight of the film purchased.

Using the cost per metre metric it is relatively easy to calculate the wrapping cost of film per pallet by multiplying the number of metres of film used to wrap a pallet by the cost per applied metre.

9.5 Film thickness

Three factors determine the effectiveness of stretch film when wrapping a pallet; the thickness or gauge of the film, the amount of pre-stretch and the wrapping pattern.

The thickness of the film is usually expressed in microns (μ).

During the study the following film gauges were observed: 7μ, 8μ, 11μ, 12μ, 13μ, 14μ, 15μ, 17μ, 20μ, 23μ. This is largely due to the fragmentation in the manufacturing and supply sector, variations in film technology and the need to differentiate the supply offering. In principle there is significant scope to rationalise material thickness.
Discussion with film suppliers identified that in the UK market the most commonly used film thicknesses are as follows:

- Machine film: 20-23 microns; and

Machine gauges are usually thicker to reduce the likelihood of accidental film breaks and enable the machine to pre-stretch the film.

The advent of lighter gauge films and pre-stretched films both provide great potential to reduce applied film thickness, and therefore the tonnage of material used by between 40-60% from current levels given widespread adoption. Specifiers and buyers are recommended to consult with their film providers to ensure that the mechanical properties of lighter gauge films are adequate for the particular load to be wrapped before introducing lower thickness films.

9.6 Wrapping Patterns

The wrapping pattern is a major factor in stabilising a palletised load. The most important aspect of the wrapping process is unitising the load to the transit pallet. This is done by first anchoring the wrap to the load by either tying the wrap to a pallet corner block or with cling film sticking the wrap to the load.

Once the wrap is anchored, the base of the load is wrapped with the film extending to cover at least the top 50mm of the pallet. Two or ideally three wraps around the pallet should ensure a strong bond between the pallet and the first layer of product.

The remainder of the pallet is then wrapped in an ascending spiral overlapping each wrap by around 40% or 50%. The top layer of the load is given extra stability by receiving two complete wraps to lock the top layer in place before descending to the base. The loose end of the wrap is then stuck to the load using the film’s natural cling, heat sealed to it or tucked inside a previous wrap. This is important as loose “tails” of wrap can be problematic especially in automated storage facilities.

This basic “standard” wrapping configuration is fit for purpose for most load types, provided the material thickness and pre-stretch are specified correctly. However for some products which are heavy and particularly free flowing e.g. bottled water, powders or granules in sacks a greater number of wraps may be necessary.

Given the infinite variety of load types, pack configurations, and distribution scenarios it is not possible to state a definitive “optimal” wrapping pattern. Users are recommended to trial various combinations of film and wrapping pattern until the optimal pattern for a particular load type is determined. Film suppliers and where applicable, wrapping machine suppliers often have considerable experience in specifying film. Users are recommended to collaborate with their suppliers in order to determine the most suitable film for any given load type.

9.6.1 Sub optimal wrapping

From observation and discussions the study determined that the wrapping patterns used across a wide variety of load types in the food and drinks sector were generally appropriate. However, it was noted that on more heavy or unstable loads operators tended to over wrap pallets. Historically many companies appear to have adopted a cautious approach to wrapping specifications in order to avoid stability issues and potential costly rejection and fines from retailers. This assumption is backed up by the low levels of damage attributed to poorly wrapped pallets reported by retailers and wholesalers at their distribution facilities.

9.7 Importance of regularly reviewing film use

Many of the companies surveyed had used the same film specification and wrapping pattern for an extended period of time, often for years, without change. As film properties have improved greatly over the last five years it is likely that for many operators both the gauge and wrapping patterns used should be reviewed to determine their suitability. Whilst this situation is disappointing it reveals further opportunities to reduce film usage through optimising both film specifications and wrapping patterns.
Some of the larger film and wrapping machinery suppliers offer a variety of auditing, consultancy, and training to film specifiers and users as part of their services. It is important that film specifiers and users take advantage of this in order to ensure that they are aware of the advantages and disadvantages of the available films and application methods and understand how to use those materials efficiently. Often film is purchased and repurchased without reference to this source of expertise.

9.7.1 Transit testing
Product damage levels: a number of the companies interviewed stated that they were currently reviewing their film use or intended to do so in the near future. Some of the larger companies interviewed had carried out transit tests by wrapping test loads with various film and wrapping configurations and driving them around simulated distribution routes to measure pallet stability.

Whilst most respondents were aware that Laboratory testing was available it was generally seen as too costly and time consuming.

9.8 Product damage levels
The study found that stretch wrapping is not directly responsible for any significant level of product damage. However, product damage can occur when poorly stabilised pallets collapse in transportation and pallet handling, although such issues are reportedly infrequent.

Stretch wrapping itself should not cause product damage if carried out correctly. The study found that over tensioning of film as it is applied to the load can cause crushing damage to load vertical edges, particularly to corrugated cases. Tensioning related damage is more likely to occur in semi and fully automated applications as the levels of tension applied by manual wrapping are much lower.

In some instances stretch film users reported the need for greater care in applying stretch film to retail ready corrugated cases with perforated side panels. Too much tension on load vertical edges can cause the perforated side panels to crease and loose load strength.

The stacking pattern of corrugated cases on the pallet can contribute substantially to the overall stability of the pallet load. Column stacking (see Appendix 1), whilst giving the greatest stacking strength is also the least stable. Brick or interlocking stacking reduces the stacking strength of the pallet load but gives greater inherent stability. It is possible to combine these attributes by column stacking corrugated cases in lower layers of the load and interlocking upper layers of the load. This offers the potential to optimise both secondary packaging material and stretch wrapping.

9.9 Managing Performance
Having determined that in many cases film use is not regularly monitored it is advisable for companies to review their stretch film use on a regular basis, at least annually, in order to take advantage of ongoing improvements in film technology and ensure their pallet wrapping operation is fit for purpose. Ideally this should be done in conjunction with their film supplier and machine supplier where applicable.

With manual wrapping operations it is particularly important to carry out regular staff training and monitor performance to ensure operational consistency and “train out” bad habits such as leaving film on “spent” rolls.

With automated wrapping it is important to have the equipment regularly maintained and tested. This is especially true of wrappers incorporating pre-stretching equipment where the rollers can become jammed with consequent detrimental effects on the machines pre-stretching capability.

10.0 Conclusions & Recommendations

Table 5 below outlines the potential size of material usage reduction opportunity for the >96% of the food and drink sector utilising stretch films, given three film technology improvement scenarios and differing rates of adoption. The benefits are calculated using the baseline total film usage indicated in 6.1 Stretch film usage in the UK food & drink sector.
Table 5 Stretch film reduction through film technology improvement opportunities

<table>
<thead>
<tr>
<th>Wrapping application</th>
<th>Scenario</th>
<th>Current usage (Tonnes)</th>
<th>UK food &amp; drinks sector Film saving (in tonnes) assuming an additional 10% Adoption</th>
<th>20% Adoption</th>
<th>30% Adoption</th>
<th>40% Adoption</th>
<th>50% Adoption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual or manual wrapping</td>
<td>Light-weighting of film by 50%</td>
<td>46,200</td>
<td>2,310</td>
<td>4,620</td>
<td>6,930</td>
<td>9,240</td>
<td>11,550</td>
</tr>
<tr>
<td></td>
<td>Increased use of coreless film</td>
<td>4,620 tonnes of cores</td>
<td>462</td>
<td>924</td>
<td>1,386</td>
<td>1,848</td>
<td>2,310</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2,310 tonnes of wasted film on reel ends</td>
<td>231</td>
<td>462</td>
<td>693</td>
<td>924</td>
<td>1,155</td>
</tr>
<tr>
<td>Machine wrapping</td>
<td>Increased use of pre-stretch film</td>
<td>30,800</td>
<td>1,386</td>
<td>2,772</td>
<td>4,158</td>
<td>5,544</td>
<td>6,930</td>
</tr>
</tbody>
</table>

Table 6 presents the potential size of the opportunity given adoption of pallet adhesive stabilisation technology displacing stretch film given differing rates of adoption.

Table 6 Stretch film reduction opportunity through the adoption of palletisation adhesive technology

<table>
<thead>
<tr>
<th>Wrapping application</th>
<th>Scenario</th>
<th>Current usage (Tonnes)</th>
<th>UK food &amp; drinks sector Film saving (in tonnes) assuming an additional 10% Adoption</th>
<th>20% Adoption</th>
<th>30% Adoption</th>
<th>40% Adoption</th>
<th>50% Adoption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative pallet stabilisation technology</td>
<td>Increased use of adhesives</td>
<td>77,000</td>
<td>7,700</td>
<td>15,400</td>
<td>23,100</td>
<td>30,800</td>
<td>38,500</td>
</tr>
</tbody>
</table>

Following a detailed review of the research outputs is it possible to reach a number of important conclusions as to the current use of palletisation films:

- Stretch film is the primary material used (>96%) in pallet stabilisation in the UK;
- The UK market for stretch film in pallet stabilisation is estimated at 140,000 tonnes annually, of which 77,000 tonnes are used by the food and drinks sector;
- Manual wrapping accounts for around 60% of use, the remaining 40% is split between semi and fully automatic wrapping machines;
The manufacture and supply of film is highly fragmented and although the market is consolidating this situation is likely to continue for the foreseeable future; whilst some stability issues are experienced by retailers and wholesalers the stability of pallets wrapped in the UK food and drinks sector is generally perceived to be good; technological advances have resulted in new films which offer the opportunity for considerable light weighting of film whilst maintaining strength; and wrapping patterns and film gauges should be reviewed regularly in order to take advantage of latest thinking and advances in film quality.

10.1 Film reduction opportunities
The main objectives of the research were to identify ways to reduce the amount of film used in pallet stabilisation and consequently the level of CO\textsubscript{2} arising and if applicable to reduce the level of product waste attributable to film use in pallet stabilisation in the UK food and drinks sector.

The research has determined the UK stabilisation film market at circa 140,000 tonnes with 77,000 tonnes being used in the food and drinks sector. Due to recent technological advances films are now available which offer the potential to reduce the amount of film used by around 50%.

These opportunities include:

- Increased use of stabilisation adhesives;
- Light weighting of manual wrapping films;
- Increased use of pre-stretch films in wrapping machines; and
- Increased use of coreless films in manual wrapping.

10.2 Film reduction opportunities from operational improvements
Whilst improvements in resin technology and manufacturing processes offer great potential to reduce film use, there are other material savings to be gained through operational improvements. The three main areas are shown below:

- Wasted and damaged film;
- Overwrapping – using too many wraps; and
- Proactive management:
  - Tracking of technological improvements in film and machinery;
  - Preventative maintenance scheduling; and
  - Consistent and proper training of hand wrap operatives.

10.3 Recommendations
The following is recommended:

- When buying film the recommended metric to use is ‘cost per applied metre’ or ‘cost per pallet wrapped’ (cost per tonne divided by number of pallets wrapped per tonne of film);
- Stretch film buyers and/or users should determine their wrapping specifications in consultation with subject experts such as film suppliers (and machine providers where applicable);
- Stretch film buyers and/or users should consider migrating to new lighter weight films whilst maintaining load restraining characteristics;
- Semi-automatic wrapping operations should employ pre-stretched films rather than standard films to optimise film yield;
- Manual wrapping operations should consider migrating to coreless films in order to minimise waste arising from spent cores;
- Operators should consider using stabilisation adhesives as an alternative to film use;
- Operators should regularly, at least annually, review their operations to ensure the optimum materials and methods are employed;
- Manual wrapping operations need to be closely managed to ensure consistency and minimise film waste.
Appendix 1

Comparison of brick stacking v Column stacking

Source: Lindum Packaging
Appendix 2: Case studies

Case Study 1: Stretch Film Lightweighting at Booker

Introduction
Booker is the UK’s leading food wholesaler. They supply approximately 338,000 catering businesses and 83,000 independent retailers. Booker operates from 172 branches throughout the UK and operates a national delivery service.

In order to replenish its business they pick and palletise mixed loads for distribution to its 172 branches. Picked orders are palletised and stretch wrapped in order to ensure safe delivery of product.

Annually, Booker distributes over 1,000,000 pallets in this way.

A recent initiative conducted in conjunction with their stretch film supplier reduced total stretch film consumption from 315 tonnes p.a. to 130 tonnes p.a. yielding a film saving of 59%

What was the issue?
- The consumption of stretch film was high and the cost considerable
- Booker wanted to be more efficient in its use of tertiary packaging whilst maintaining pallet load integrity
- Booker wanted to reduce cost and environmental impact

What Booker did
Booker manually stretch wrap (hand wrap) 1,039,539 mixed product pallets for distribution from their regional distribution centres to their 172 branches. Each 1200mm x 1000mm pallet load dispatched is wrapped using between 10 and 12 complete wraps of stretch film per pallet. The
wrapping pattern is twice around the base of the load, 6 to 8 wraps (load height dependent) up the load with 50% overlap and twice around the top. The film is applied manually using extended core 400mm wide hand wrap.

Prior to the initiative Booker were using 17μm stretch film. Working with their supplier they discussed opportunities for improving film efficiency and tested the same film but pre-stretched by the manufacturer by approximately 300%. All other wrapping parameters remained the same. The resulting film was reduced in thickness to 7μm, whilst retaining its tensile strength.

**What was achieved?**

- A reduction in average film usage per pallet from 303g to 125g;
- A reduction in annual film consumption from 315t to 130t;
- Carbon emission reductions of 500t p.a.;
- Greater than 50% saving in film cost; and
- Improved load consolidation.
Case Study 2: Increasing the Pre-stretch Ratio of Stretch Film to Increase Yield

Introduction
A large UK based ambient food manufacturer supplying product into the fast moving consumer goods (fmcg) supply chain palletises and stretch wraps product specific pallets using an automatic stretch wrapper:

94,000 pallet loads of product are manufactured annually.

Utilising a new improved film the company increased the pre-stretch ratio of the machine to reduce film consumption from 22.8 tonnes p.a. to 13.1 tonnes p.a. yielding a film saving of 43%.

What was the issue?
- The company was seeking ways to reduce packaging spend without compromising product quality; and
- One of the company’s KPIs is to reduce their carbon footprint.

What the company did
The company utilise a fully-automatic machine to stretch wrap 94,000 pallets for distribution through the retailer regional distribution network. The machine has a pre-stretching capability allowing it to take standard stretch film and pre-stretch it at the point of application in-line in the manufacturing facility. The film used was 20μ using a pre-stretch ratio of 100%.

Each 1200mm x 1000mm pallet load dispatched is wrapped using on average 12 complete wraps of stretch film per pallet. The wrapping pattern is three times around the base of the load, 7 wraps up the load with 50% overlap and twice around the top.

Working with their machine and film supplier a new improved film was introduced allowing the pre-stretch ratio to be increased to 250%. The film thickness and reel width remained the same.

The new film and increased pre-stretch ratio were trialled to ensure that wrapping efficiency was not compromised and that load stability was satisfactory in distribution.

What was achieved?
- A reduction in average film usage per pallet from 242g to 138g;
- A reduction in annual film consumption from 22.8t to 13.1t;
- Carbon emission reductions of 26.2t p.a.;
- 33% saving in film cost; and
- Wrapping efficiency and pallet stability maintained.
**Case Study: Massey Feeds replace stretch film with “Lock n’ Pop” stabilisation adhesive.**

Massey Brothers is a family owned manufacturer of a wide variety of animal feeds and agricultural products with 125 years experience in the animal feeds business. The company operates from two manufacturing sites located at Preston in Lancashire and Holmes Chapel in Cheshire. Additionally, the company sells its products through three company owned cash & carry outlets located at Longor and the two manufacturing sites in Preston and Holmes Chapel.

The company manufactures around 27,000 tonnes of bagged feeds a year and the business is experiencing steady growth in demand for its products.

The company has been quick to adopt new technologies and processes in order to increase its performance and has completely removed the need to stretch wrap outbound products by switching to use “Lock n’ Pop” stabilisation adhesives to stabilise palletised loads.

**What was the issue?**
- The main aim was to remove the process step of stretch wrapping palletised loads which was increasing the loading time for distribution vehicles
- The company was also seeking ways to reduce packaging spend without compromising product quality

**What the company did**

Animal feeds are sold in various pack formats but mainly in plastic sacks weighing 25 kg. Palletised loads weigh 1 tonne. A semi-automated wrapping machine was used and palletised loads had to be physically moved from the end of the production lines in each plant to the wrapping area prior to wrapping. The wrapping operation utilised 25 micron stretch film which was applied to the load in 12 wraps around the standard pallet.

The company considered alternative wrapping methods and materials before deciding to trial water based stabilisation adhesives. Following successful trials the company adopted this method of stabilising its products. The only capital requirement of the change was installing the required spray equipment in-line at the point of palletising the load.
The spray installation did not take up much space and as the adhesive is applied cold there is a minimal energy cost to operate the spray applicator.

Once the water based adhesive is applied it quickly dries securing the sacks in place. The high shear strength of such adhesives holds the sacks in place during distribution but easily releases packs when picked from the load.

What was achieved?
Since switching from stretch wrapping of loads to using ‘Lock n’ Pop’ stabilisation adhesives the company has achieved its primary objective of streamlining the palletisation process by cutting out the need to stretch wrap its loads. This has reduced overall production time by 5 minutes per tonne.

The most impressive achievement has been the near total removal of stretch film from the operation. If stretch film was still used today the volume of film used would be: 27,000 pallets x 12 wraps x 4.4 metres = 1,425,600 metres, 25 micron film weighs approximately 12g per metre so the weight of film saved is=17.1 tonnes per annum

The benefits of switching can be summarised as:
- Estimated film saving of 17.1 tonnes a year;
- Estimated Saving of 1011 cores weighing 1.2Kg each = 1.2 tonnes of cardboard;
- Carbon emission reduction of 34.2 tonnes p.a.;
- Adhesive gives a significant saving against film;
- Reduction in manufacturing time;
- Pallet stability maintained; and
- Increased convenience for customers who do not have to dispose of waste film.
Case Study 4: Multiple Retailer chooses coreless film.

A multiple retailer with a UK wide network of distribution facilities recently reviewed its use of stretch wrap to secure loads on pallets and in roll cages with a view to improving its film use and reducing costs.

The distribution operation was using conventional 14 micron manual wrapping film on extended cardboard cores but was concerned at the amount of film it was using and the costs associated with dealing with waste film and spent cores.

In order to determine the efficiency of the current situation the retailer conducted an internal audit of the pallet wrapping operations at its four main regional distribution centres (RDCs).

The result of these audits was clear and showed that the company was experiencing a number of issues which lead to film being poorly applied and more importantly large quantities of film was being left on “spent” cores. On average the last 60 metres (20%) of film on a 300 metre core went to waste, sometimes considerably more film was wasted in this way.

Given that each of the four RDCs was using around 5,000 reels of film per month and that each core weighed around 300 grammes the four RDC’s were producing around 6 tonnes of waste cores per month.

The waste film left on these cores was also around 6 tonnes per month – equivalent to 12,000 full rolls of film wasted per annum.

Not only was this film wasted but additional labour costs were incurred in stripping the waste film from the cardboard core to enable it to be recycled.

What was the issue?

- Unacceptable levels of waste film were being left on “spent” cores.
- Lighter gauge hand films were available than the current specification
- Waste handling costs too high

What the company did

To rectify the situation the retailer collaborated with its film supplier and shared the findings of the internal auditing. Initially it was felt that the issues could be solved by moving to a much lighter
pre-stretched 7 micron gauge film. However, through a process of on-site reviews and discussion it became clear that the most urgent issue to tackle was that of waste film left on cores. Waste film had to be manually cut off spent cores before it could be sent away for recycling.

The solution proposed by the film supplier was to use pre-stretched 7 micron “coreless” film. Coreless films are a relatively recent innovation whereby the traditional heavy cardboard core is dispensed with. Instead, the operator has to place the film reel onto a detachable handle to apply the film to the load.

Accordingly trials were set up at each of the four main RDC’s backed up by training in best practice wrapping techniques provided by the film supplier.

What was achieved?
Across the four sites the business removed the need for baling and disposal of 72 tonnes of cardboard cores and reduced film waste to less than one tonne from the previous 74 tonnes with conventional film.

Additionally, the coreless film reels hold 600 metres of film against the conventional film reels holding 300 metres. This in effect halved the number of film deliveries required yielding further savings in C0₂ emissions.

- The company is now rolling out coreless film to its other distribution centres.
- The benefits of switching can be summarised as:
  - Estimated film saving of 73.0 tonnes a year;
  - Estimated saving of 72.0 tonnes of cores a year;
  - Reduced waste handling costs in RDCs;
  - Carbon emission reduction through reduced film deliveries; and
  - Pallet stability maintained.
Case Study 5: Working Collaboratively to optimise pallet wrapping operations

A large International drinks manufacturer produces around 450,000 pallets of product a year from its 3 UK manufacturing operations and in order to cope with such high volumes of throughput it uses fully automated wrapping machines at each of its sites.

What was the issue?
- The company wanted to reducing the packaging and CO₂ impact of its operations
- There had been issues of film tearing on application and heavier gauge film had been used to get around the problem.
- The company was also seeking ways to reduce packaging spend without compromising product quality

What the company did
The company considered alternative wrapping methods and materials internally before deciding that the best way to optimise its palletisation operation was to form a working group consisting of the in-house Packaging Technologist responsible for palletisation films across the three sites, the relevant stretch film suppliers and the suppliers of the wrapping machines.

What was achieved?
Following a series of on-site meetings the working party decided to trial varying combinations of film and machine pre-stretch settings in order to arrive at the optimum wrapping patterns for each of the company’s main product pack formats.

Early in the process it was discovered that a maintenance issue with one of the wrapping machines was causing the film to tear. Having corrected this issue it was possible to revert to lower gauge film in this machine with a consequent saving in film.

Working collaboratively also removed the possibility of a “blame culture” with the film and machine suppliers blaming each other for stabilisation issues and enabled further discussions which resulted in wrapping patterns being amended. This resulted in a saving of 2 complete wraps per pallet across all sites.

The trials are still continuing but by taking a collaborative approach the company has already seen a number of benefits which can be summarised as:

- Film gauge reduced from 25 microns to 20 microns;
- Wrapping pattern reduced by 2 wraps per pallet across all sites;
- Improved machine maintenance has reduced film breakages;
- Packaging spend on stretch films reduced by 25%;
- Less machine downtime; and
- Pallet stability maintained.