CRR Corporatewear Project 2008/2009

Use of alternative Fibres in Corporatewear

Uniformreuse is run by the CRR

CENTRE FOR REMANUFACTURING & REUSE

Sustainable Corporate Clothing: Alternatives for the future.

Summary

In the context of this report corporate clothing does not take into account clothing that is provided as personal protective wear. The wide range of garments that come fall within the corporate clothing sector inevitably mean that there is a range of fibres/fabrics used. Current performance requirements often necessitate the use of blended yarns rather than homogeneous ones and this has a serious impact on the end of life disposal from corporate use.

Sustainability is becoming a major issue with textiles and recent developments have lead to a new generation of regenerated cellulose fibres (lyocell and bamboo) and a renewal of interest in natural fibres such as flax and nettle. The availability of the regenerated cellulose fibres is sufficient to attract interest by the corporate clothing sector but they have yet to make a market impact. Natural fibres have advantages in terms of their durability however the supply chains, within the UK, for these materials are still very much at the development stage and it is unlikely that these will be in a position to satisfy potential markets within the foreseeable future.

The range of end of life possibilities and preferred options will be influenced by the nature of the fibre/fabric in use however there is a need to ensure that fibres/fabrics are placed into the correct disposal stream. Identification and sorting of the garments is therefore an essential part of the process and probably provides one of the biggest barriers to decreasing the levels of textiles sent to landfill. This is an area being given separate consideration. Corporate clothing is often designed to provide a company image and the provision of company identities on the garments is frequently an integral part of the garment design. Disposal of such garments requires careful consideration and is under review elsewhere.

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1. Introduction

The fundamental characteristic of corporate clothing is that it is supplied by an employer to be worn by the employee as a means of identity. It is a term that may be applied to garments used in a broad spectrum of applications and will therefore be manufactured from an equally broad range of textiles. Clothing supplied as corporate wear must carry some form of tax tag in order to overcome potential tax liabilities for the wearer. Corporate identity, often involving the use of logos, is necessary during service life, their presence can provide obstacles to easy recycling, reuse or remanufacture. Clearly there is a security issue associated with these factors, persons wearing corporate clothing will more often than not be accepted as belonging to that organisation without any need to check for authenticity. Disposal at the end of life is therefore a crucial part of corporate clothing provision and may require shredding or burning but could also include recycling or disposal to landfill. Within the context of the following report the term “recycling” will be used to cover options of recycling, re-use and remanufacture.

There are many recommendations provided relating to corporate clothing. As a matter of policy all garments issued to workers should be returned to the employer when the employee leaves the organisation. A similar policy for the return at the time of re-issue/replacement will ensure that garments are returned to a single point for disposal in an approved manner. These policies can provide a readily made means of collecting items for recycling

One important factor that influences the selection of corporate wear is performance. This may be as a visual marker of the corporate identity or the durability of the garment to satisfy the user for a suitable period of time. Poor performance measured against any criterion can be detrimental not only to the employer but also the supplier. Furthermore either poor performance or poor quality may adversely affect employee self esteem and result in a reduction in personal performance. This requisite to achieve the desired level of performance will often necessitate the use of blended yarns which can have a negative impact on the ease with which they can be recycled.

The life of a corporate garment can generally be considered to be 12-18 months, though some specialist areas have significantly shorter life expectances than this. Faced with this, fabrics and garments undergo stringent testing prior to entering service. With the larger corporations new designs will often be field trialled before general release. The outcomes from any testing will be expected to exceed those considered to be acceptable for high street garments. Selection of the correct fibre combinations, fabric design and manufacturing processes are therefore critical for successful corporate clothing.

The corporate clothing market in the UK and Europe has shown and increase over recent years, however more lately this has tended to level off. A review of the corporate clothing market (Gill & Willis 2007), provides a comprehensive range of data. These show that over the past fifteen years there has been more than a 20% fall in the number of people wearing corporate clothing (see figure 1), however during the same period the value of the market has increased by approximately 7% (see Figure 2). Despite the fall in the number of wearers there has been an increase in the number of garments issued (see Figure 3).

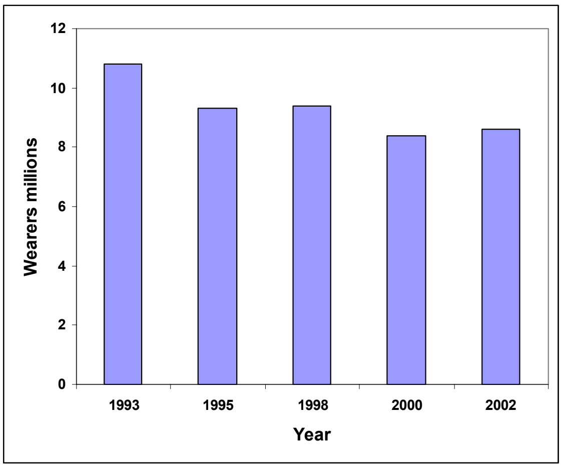

Figure 1 Corporate Clothing Wearers 1993-2002

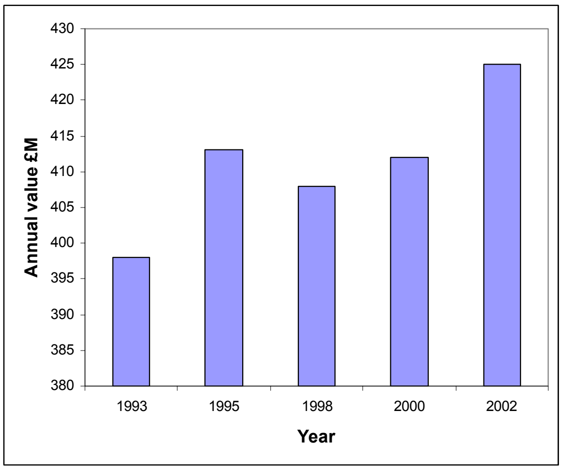

Figure 2 Value of Corporate Clothing Market 1993-2002

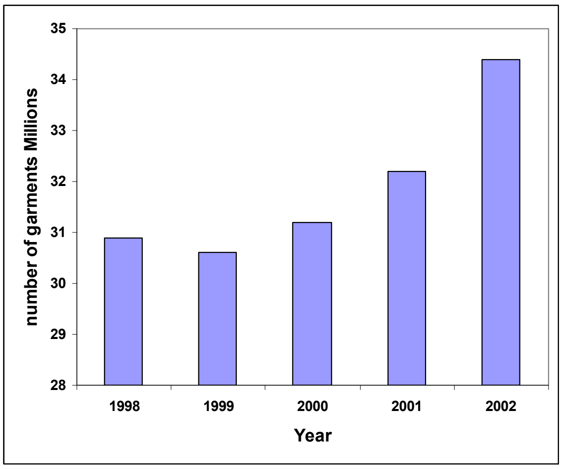

Figure 3 Number Of Corporate Garments Issued.

These changes have also been accompanied by shifts in attitude to garment sourcing and to the type of garments wanted. Whereas the garment rental business had been the number 1 way of providing corporate clothing this is no longer the case, direct purchase is now a more favoured approach to sourcing of the garments. Manufacturers are now supplying directly to the large corporate market providing the individual touch that the buyers want (see figure 4). Many of the UK companies providing corporate clothing to their employees now have an international operation and garments may be sourced from a distant operations centre.

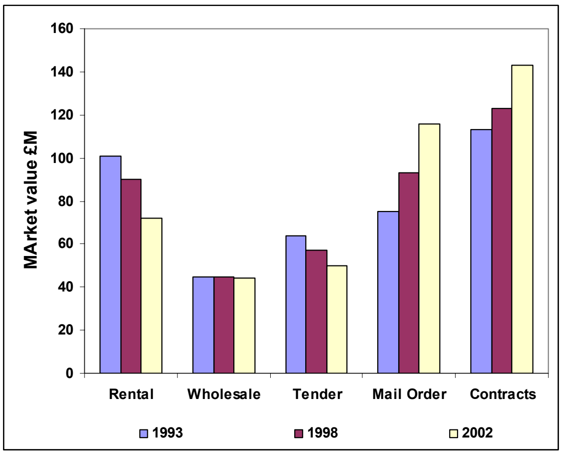

Figure 4 Changes In Market Value For Supply Sources 1993-2002

Changing attitudes are also resulting in a shift towards a greater amount of leisurewear being used within the corporate environment (see figure 5).

Figure 5 Value (£M) of Product market share

Any look into the fabrics used in corporate clothing will immediately show that there are numerous variations and the purpose of this report is to provide an overview of the fabrics that are in use. Corporate wear is normally considered to cover five categories of clothing; work wear, career wear, corporate casual wear, protective wear and uniforms.

For the purposes of this document clothing has been broken down into different categories that relate to the applications. Within these the textiles used have been reviewed.

Clothing within the emergency services and armed forces, while being used to portray an identity, is not normally considered to be corporate clothing. The end of life disposal of these (uniform) garments possesses a high level of security issues and there are usually strict rules regarding their disposal. While attention has not been paid to these garments specifically, notes relating to their composition and fibre disposal can be applied.

2. Definitions

There is often a degree of confusion over the numerous terms that are applied to the end of life processes, is recycling the same as re-using for example. It is not the purpose of this report to provide any in depth description of the different process however a brief definition of some of the terms used was considered to be appropriate.

Biodegradable: Aerobic decomposition of organic matter through the action of micro-organisms or aerobes. There are no standards for eco-toxicity or length of time before degrading to biomass and, in some cases, eco-toxins.

Bleaching: A process for improving the whiteness of textile material with or without the removal of natural colouring mater and extraneous substances

Colouration (Dyeing): The application and fixing of a colour (dye or pigment) to a substrate, normally with the intention of obtaining an even distribution throughout the substrate

Compositing: biological process applied to degradable waste rendering it suitable for use as a soil conditioner often containing plant nutrients.

Degradable: A material that undergoes chemical change and a loss of original characteristics due to environmental conditions. There are no requirements for time, process or toxicity for this method.

Dimensional Stability : a) The ability of a fabric to retain its dimensions when exposed to use and/or an ageing process, to water, washing, steaming, drying or other process.
b) Changes in length and/or width of a textile when subjected to specified conditions

Disassembly: non-destructive taking apart of an assembled product into materials and/or components

Disposal: permanent loss of material as waste to the environment

Durability: The ability of a textile to perform to its required function until an agreed limiting state is reached.

End of life: point at which a product is taken out of use.

Recondition: Return a used product to a satisfactory working condition by rebuilding or repairing major components that are close to failure, even where there are no reported or apparent faults in those components

Recycle: reprocess waste material either for its original purpose or for other purposes

Remanufacture: return a used product to at least its original performance with a warranty that is equivalent or better than to that of the newly manufactured product

Repair: Returning a faulty or broken product or component back to a usable state A repair may use remanufactured or reconditioned parts.

Reuse: operation by which a product or its components are used for the same purpose at the end of its current life

3. Fibre types and demands

Within the corporate clothing sector the demand for fibres is being met by both natural and synthetic fibres. Natural fibres, primarily cotton and wool, provide the user with the necessary comfort and durability that the end user requires from the products. Synthetic fibres such as polyester are used to improve the easy care properties, especially with the natural cellulosic fibres such as cotton.

During the past 35 years the global demand for fibres has continued to increase and much of this increase has been met by the wider use of oil-based synthetic fibres (see figure 6). Recent information for the period 2006 to 2007 shows that the usage of cotton, wool and silk increased by 1.2% to 28.5 million tonnes, while manmade fibres rose by 8.0% to 44.1 million tonnes

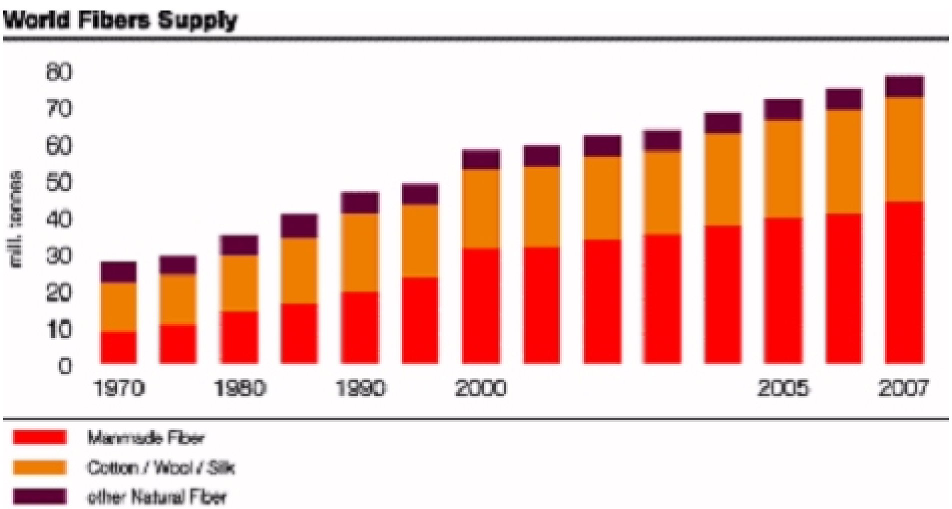

Figure 6 World demand for fibres

(http://www.oerlikontextile.com/)

Trends towards garments with a greater degree of functionality have resulted in many fabrics used in corporate clothing having a finish applied to them. The purpose of this is to enhance their properties. Easy care, soil resistance and fire retardant treatments are often encountered. These will also influence potential end of life disposal possibilities.

An indication of the types of fabrics can be gauged from data from Carrington Career & Workwear Ltd., who supply into the work wear, career wear and corporatewear markets in excess of 30 million metres per year as woven fabrics. The major proportion of this, 87%, is in the form of polyester/cotton blends. While this covers a range of blend ratios from 67% polyester/33% cotton to 60% cotton/40% polyester, the vast majority is in polyester rich blend (about 3/4) with cotton rich second and a small amount of 50/50. Supply of single fibre type fabrics is mainly with 100% cotton, (87%) and the remaining 0.5% in 100% polyester. In addition to these fabrics, a small amount of polyester/viscose blend is supplied for school wear. More specialist blends include cotton/nylon blend into high abrasion resistant flame retardant work wear and 100% nylon into load carrying equipment (Cordura) and body armour covers

4. Clothing categories

Research has shown that the fabrics used within different garment types tend to follow similar patterns. Significant differences will exist between near skin garments such as blouses and shirts and outer wear. It is therefore convenient to review the fabrics used within broad categories that represent the garment type.

Single users can require a significant quantity of a particular garment, for example an operation like London Underground will issue approximately 80,000 shirts and blouses in any year along with 60,000 pairs of trousers, 4000 jackets and 5000 anoraks. Security issues associated with these garments largely dictates their end of life destiny.

4.1 Shirting & Blouses

Important factors that contribute to the choice of fibres within this group of clothing are comfort and easy care. These attributes are found in blended materials based on cotton and polyester. This combination provides the user with a degree of moisture management that will give the comfort required from these garments. A favourite combination of fibres for shirting & blouses is a standard 65% Polyester/35% Cotton. The levels of comfort and breathability that this blend offers makes is it suitable for application in a wide range of industrial sectors and will be found in clothing used for example, within the transport, hotel, leisure and retail. The composition of the blends is not unique and higher cotton blends are used where comfort is of paramount importance. The use of 100% cotton does not find favour with corporate clothing, largely due to the poor colour fastness over the working life of the garment. Blending the polyester with the cotton provides an improved level of easy care and reduces the need for pressing garments. Addition of Lycra, or similar elastane fibre, is often made where it contributes to the performance and fit and can also enhance the life of the garment.

Polyester is also used in a wide range of products as an unblended fibre. This is especially true in the case of ladies blouses & tops which are commonly constructed using a 100% Polyester or a 97% Polyester/3% Lycra blend. These fabrics often find applications in garments used within the hotel industry for management and front of house staff where the appearance is critical. Certain trademarked polyesters like Coolmax are used in performance garments where high activity levels or changes in temperature are encountered.

In addition to the varied fibre content of the fabrics, it will also be found that the fabric weight will vary. Fabrics will not necessarily be a simple weave, other patterns will be required by some users.

Finishes can be applied to fabrics used for shirts and blouses and in the case of 100% polyester an anti-static finish is one such treatment. While the finishes may provide performance enhancement in some directions there is sometimes disadvantages. A simple example of this is in the use of antistatic treatments, which when applied, can have a detrimental effect on the colour of a garment, resulting in changes to the colour after application.

Fibres used: cotton, polyester, elastane (Lycra)

Compositions: Usually blended wide range of compositions, only occasionally 100%.

4.2 Suiting Fibres

It is essential to realise that the construction of garments within this category is far from simple. If a suit jacket is considered the outer fabric and inner lining are two areas that immediately come to mind. However between these layers are several other interlining fabrics, (see figure 7), present to provide the stiffness and shape required from a tailored garment. These fabrics vary not only in construction but also composition. End of life considerations for such a complex mixture do therefore provide several obstacles.

Figure 7 Cut away section of a suit jacket.

As with fabrics used for shirts and blouses it is unusual to have fabrics that consist of a single fibre type. These garments are usually given a life span of 12-18 months which makes performance of the fabrics critical to the needs of the customer and therefore fibre choice and construction are important. Comfort is often an over-riding characteristic of materials used for suiting. While wool provides the necessary characteristics associated with comfort, it often lacks the durability. For this reason unblended wool is rarely used but wool blends are among the most common types of fabrics used. Wool blends vary in both the constituents and composition.

The most common type of suiting fabric is a 55% Polyester/45% Wool blend. This combination gives the desired performance and comfort properties required. It therefore finds widespread use, especially in the transport industry. The addition of elastane fibres gives enhanced stretch and improves fit and is often used for example in 44% Polyester/54% Wool/2% Lycra fabrics. A less common fabric is based on a blend of 65% Polyester/35% Viscose. In this combination the role of the viscose is similar to wool in the other fabrics.

Linings tend to be made from 100% polyester fabrics although continuous filament viscose and acetate fibres can also be found used. Interface fabrics, stiffening, shoulder pads are often found fibres such as polyester, viscose and cotton. The use of bonded non-woven structures as interlinings, often using viscose fibres with polypropylene or latex adhesives, introduces yet a further difficulty to impede easy recycling.

Inevitably the suiting quality will vary, fabric weave patterns and weight will change depending on, among other influences, the prestige the corporate body attaches to its image. Heavier weight better quality fabrics will go into some applications and these may well represent the areas where the total market volume is lower.

Fibres used: Wool, polyester, viscose, elastane (Lycra), acetate, nylon

Compositions: Complete garments will have a mixed composition, as will individual fabrics used in the construction.

4.3 Outerwear

Fabrics used for outerwear tend to exclude natural fibres. The ability to produce fibres with specific properties is a significant influence on the choice of fabrics. These garments can readily be split into those which provide a high level of protection against adverse weather conditions and those that are essentially providing thermal insulation.

Thermal insulation is usually provided by fleece fabrics and this may be present as a lining for waterproof garments or as a separate garment such as a body warmer or fleece. Fibres used in these fabrics include polyester, nylon and acrylics. Usually the fleece will be constructed from a fabric containing 100% of one fibre type.

Garments required to have waterproof properties will often be based on nylon or polyester fabrics that have a polyurethane coating. The latter provides the fabric with the water proof qualities required. There will often be several layers in any garment used in a corporate environment to provide protection when working outside and it is critical that the fabric provides the correct degree of breathability coupled to adequate waterproofness. The outer layer is commonly a woven fabric whilst any inner layer provides protection to the coating and is often knitted. More technical garments will use PTFE (Goretex) or polyester (Sympatex) membranes. Membranes and coatings can be applied directly to the outer fabric, to the inner fabric or even a separate drop liner fabric. Seams and stitches will be sealed with a chemical dope or taped to prevent ingress of water. In each of these cases recycling will need careful attention. An insulation layer built in to waterproof garments is often a polyester wadding.

Fabrics polyester, nylon, acrylic
Composition blended and 100%, coated or laminated membranes

4.4 Leisurewear

In the corporate wear market, leisure wear garments include polo shirts, t-shirts, sweatshirts and knit wear garments such as slipovers & sweaters. While this appears to cover an extremely broad range of applications the fabrics fall generally into two categories. These are cotton/polyester blends and Wool/acrylic blends.

The former category tends to be used for items such as polo shirts, tee shirts and sweat shirts where the weight and construction of the fabric can be varied to give the desired performance to the individual garments. Most blends are based on a 65% polyester/35% cotton blend where this combination provides the easy care characteristics that are derived from the polyester while maintaining sufficient comfort from the cotton.

Knitwear, such as slipovers and sweaters, tends to use wool acrylic blends, with combinations ranging from 80% Acrylic/20% Wool to 50% Acrylic/50% Wool. The durability of this combination makes it suitable for use in the transport industry.

Fibres used: cotton polyester wool acrylics

Composition usually blended with a range of compositions

4.5 Accessories

Many garments used within the corporate clothing market will have some form of identity included in the design. These logos and similar will present difficulties and removal is often critical. The problems associated with the removal of these are outside the scope of the current study.

Button and zips are an integral part of most garments and these will have some influence on the end of life possibilities for any product. The increasing use of hook and loop fasteners (e.g. Velcro) will also add further difficulties. Materials used to produce zips may be plastics or metal and the ways in which these can be re-cycled will be strongly affected by the composition. Further information relating to these aspects of garment construction is being collected and the impact of these on the end of life possibilities will be reported later.

Materials used include: metals including brass and steel, polyester, nylon

4.6 Applied finishes

In order to enhance the fibre properties and performance many fabrics will have finishes applied to them. The presence of these can interfere with potential recycling options. Many of the polyester/cotton fabrics are resin finished with zero formaldehyde dihydroxy-dimethylol ethylene urea (DHDMEU) type resins in order to provide a crease resist fabric and also improved wash stability. Increasing quantities of fabrics are flame retardant finished using for example the Proban process. This treatment is being applied especially to 100% cottons and cotton rich polyester blends. Two other properties that are being enhanced using treatments are water/oil repellency where fluorocarbons finishes are applied and antimicrobial protection using products such as 'Permagard'

4.6.1 Stain resist finishes.

These are applied to the textiles in order to reduce the tendency of soiling to occur. Stain resist treatments often involve the use of fluorinated polymers such as Teflon. These will be applied to the finished fabric or garment. The presence of these treatments can have an adverse affect on the end of life opportunities through which the garments can be processed.

4.6.2 Easy care finishes.

Natural cellulose fibres have a tendency to crease easily and therefore require pressing/ironing after laundering. Treatments are available that can be applied to the fabric to reduce this requirement. These treatments tend to cross link and stiffen the fibres.

4.6.3 Anti microbial finishes.

Antimicrobial properties can be achieved using a variety of methods. With synthetic or regenerated cellulose fibres it is possible to spin a suitable material in the dope so that the treatment exists throughout the fibre core. This will then provide a long lasting protection. Different products are available to achieve this and fibre Amicor is an acrylic fibre that uses this technology.

Treatments can be applied to the fabrics using micro-encapsulated materials or nano-particles of active material such as silver. The long term durability of these products under repeated washing may be in doubt. A third approach is to incorporate active fibres such as silver, into the weave of the fabric. These will then provide an active zone around the fibre. It should be remembered that many of the treatments that rely on the use of metal ions for their activity will only be applicable in environments where they are moist. This may be the case in near skin garments but other garments may not have sufficient moisture present to be active.

The presence of these antimicrobial treatments on the fibres/fabrics will affect the end of life opportunities. They will tend to prevent the enzymatic actions that are responsible for degradation and their presence in landfill can result in them being taken into water courses over time. Incineration may be the only sensible means of destroying the fabrics at their end of life.

4.6.4 Anti-fibrillation treatments

Lyocell fibres are particularly prone to fibrillation which will result in poor pilling resistance. Modified processing of the regenerated cellulose with the incorporation of cross linking catalysts into the spinning process enable fibrillating resistant variants to be produced Tencel A100 is an example of this sort of product. Standard lyocell and other cellulose fibres that have a tendency to fibrillate can be given a cross linking treatment similar to the "easy care" that is applied to cotton. The presence of these treatments will inevitably result in a reduction in the ease with which biodegradation will take place and place restriction on the end of life opportunities.

4.6.5 Fire retardant finishes

The majority of textiles used within the corporate clothing sector are used in environments where fire retardant properties are not the prime requirement. As with many finishes there are at least two ways to achieve the required degree of fire retardancy. Fibres can be spun from polymers than are inherently FR in their nature, Modacrylic fibres are typical examples of this class of material. Fibres that have do not have this inherent property can however be spun containing additives that impart FR properties to them and this approach is often found with polyester fibres. A final approach is to apply some treatment to the finished fabric or garment. With the multitude of fibre and fabrics that are available an equally broad range of products have been developed. Careful consideration must therefore be given when FR garments reach their end of life.

5. Blends versus Homogeneous yarns

One of the major obstacles to recycling of textiles is the use of blended fibre yarns. Homogeneous material can potentially be treated as yet one more source of raw material for processing into fabric of that origin. Blended yarns do however present a greater problem. There are however some blends which can be treated easily as a raw material source for re-manufacture.

The first issue to address is why are blends used? The simple answer to the question is to modify the properties of the yarn. Within the corporate clothing sector, the most frequently encountered blended yarns contain a mixture of cotton and polyester. These yarns do not conform to a single blend ratio but will cover a wide range from cotton rich to polyester rich yarns. Each will have different properties that are influenced by the fibre that is present in the greater concentration.

What therefore does a cotton polyester fabric have to offer that a homogeneous yarn doesn't? Cotton has the potential to absorb moisture, to wick it away form the skin and thereby provide a degree of comfort to the wearer. The same cannot, in general, be claimed for polyester. Cotton is a natural fibre which can be considered to be sustainable, although the environmental impact it has during growing and processing is considerable. Unless chemically treated, cotton does not possess easy-care credentials. Polyester on the other hand is an oil-based synthetic fibre that relies on the ever depleting reserves of oil for its raw material. The chemical industry set up to manufacture the raw material for spinning the fibre has a serious environmental impact. The moisture absorption of polyester is not good, however in it does exhibit excellent easy-care properties. The result of combining the two fibres allows optimisation of the yarn properties so that it possesses a level of easy care and moisture management that makes it suitable for widespread use.

Optimisation of the yarn properties during use of the life of a garment does not indicate that the fibres can be readily handled at their end of life. The fibre content in a garment must be detailed on labels within the item these labels are often simple printed tags that fade with laundering. At the end of life it may be expected that these labels will not be clearly visible and therefore identification of the fibres used with a blend cannot be readily identified. In order to facilitate easy separation a labelling system is required that requires the minimum of study to identify the course of action to be taken. This is being investigated as a separate issue.

6 Fabric constructions

6.1 Woven

A woven fabric consists of interlaced warp and weft yarns that can range from a simple weave where each warp yarn passes over one weft and under the next. By varying the frequency of the yarn crossing a range of patterns can be generated on the fabric face (see figures 8 & 9).

The tight structure that results from weaving provides a fabric with a significant level of dimensional stability. The nature of woven fabrics make then suitable for many different types of garment and forms the largest type of fabric construction used incorporate clothing.

Figure 8 Plain woven fabric

Figure 9 Patterned weave

6.2 Knitted

A knitted fabric is much looser than a woven one and it is formed by interlocking loops of yarn (See figure 10). Often knitted fabrics will have a bulkier feel to them and this provides knitted fabrics with the ability to trap air in the structure making it ideal for garments where the thermal insulation properties afforded by the high bulk, are used to an advantage. It sees its largest use in jumpers and leisure shirts within the corporate clothing sector.

6.3 Non-woven

Whereas woven and knitted fabrics have a construction that is based on yarns, non-woven fabrics tend to be based on fibres. These are laid down in a random fashion to provide a mat of fibres that can be used as a fabric (see figure 11). As a mat of fibres the properties will be poor and it is necessary to provide some form of coherence to the fabric. The cohesion of the fibres can be improved by the use of processes such as needle punching, hydro-entanglement and the use of binders. Latex adhesive as an adhesive to bind the fibres and sometimes polypropylene is used to thermally bond the fibres.

Non-woven fabrics are not used widely in corporate clothing except as interlinings for jackets.

Figure 10 Knitted fabric.

Figure 11 Non-Woven fabric.

7 Alternative fibres

7.1 Manmade fibres

7.1.1 Lyocell

This is a regenerated cellulose fibre that has yet to make a significant impression in the corporate clothing market. Often sold under the brand name Tencel, Lyocell is the generic name of fibres produced using a solvent system based on N-methyl morpholine oxide (NMMO). Produced using a closed loop system, lyocell fibres have a much lower environmental impact than similar fibres produced using the classical viscose process. Solvent recovery is high and very close to 100% and the use of water in the process is also very low. Raw material for the process remains as pulp however there is the potential to utilise other forms of cellulose.

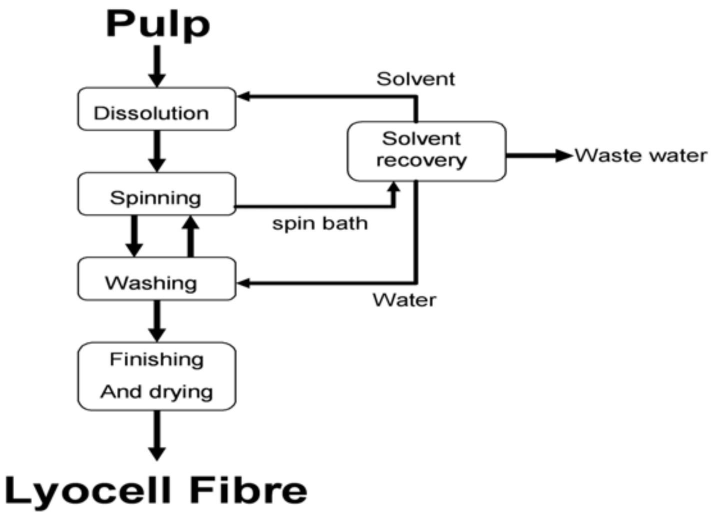

Figure 12 Lyocell process flow chart

Lyocell can claim to have strong sustainability, wood used as a source of the pulp raw material is farmed like any other crop. The major difference remains the growth cycle for the trees is approximately 8-10 years. Alternative sources of cellulose can be used and the process offers the potential for using waste cotton and natural cellulose fabrics.

Lyocell has become popular in clothing because it is absorbent and comfortable for wear, especially in conditions of high humidity. Lyocell breathes and washes like cotton, yet has the soft, fluid, natural draping qualities of rayon with a luxurious and refined look. With these properties, lyocell is well suited to applications such as dresses and shirts.

Lyocell has many advantages over viscose and cotton as a fibre for corporate clothing. Being stronger than either cotton or viscose provides the fibre with more durability. Wet strength has always been an issue for viscose fibres and this problem is overcome when lyocell is used. These favourable improvements in the fibre properties are offset by the lower elasticity the fibres have. The better mechanical properties associated with lyocell means that blending with cotton or polyester can result in a new range of fabrics that will offer advantages within the corporate clothing sector. Cotton blended with lyocell becomes stronger and wool/lyocell blends are more absorbent. Lyocell may also be blended with other natural fibres such as wool, cotton, silk, flax and various synthetic fibres.

One specific property associated with lyocell is the ability to fibrillate. Fibrillation occurs when the wet fibre is abraded such as may take place during machine washing. The surface of the fibre breaks down into small fibrils that will affect the appearance of the garment. Within the corporate clothing market this can be a serious disadvantage, however this can be overcome at the manufacturing stage by applying suitable finishes to the fibre. It is also possible to use the natural tendency to fibrillate to advantage and produce fabrics with soft peach skin surface. These could have niche applications within the corporate clothing sector.

Being a cellulose fibre means that lyocell cab be readily dyed. The nature of the fibres is such that they can take up colour form the palest tints through to the deepest of colours.

Lyocell is a relatively easy to care for fibre. Garments made from lyocell may be suitable for either machine washing or dry-cleaning. Machine washable lyocell can be washed at low temperature and tumble dried. It should be removed from the drier as soon as it is dry. If ironing is required, use a moderately warm iron.

7.1.2 Modal

Modal is a variation of viscose that is produced from sustainable sources of trees. The fibre is produced using the viscose process with modifications to the spin bath composition and spinning conditions. Under these modified circumstances the fibre cross section is altered, showing less of the deep crenulations and giving the fibre a more kidney shape to its cross section.
Modal fibre has several advantages over viscose. The low wet strength normally associated with viscose is replaced by a high wet modulus in Modal and the fibre is also more crystalline. Moisture adsorption and regain properties are similar in many respects to viscose.

7.2 Natural fibres

7.2.1 Bamboo.

The potential for bamboo fibres cannot be underestimated because of the properties that are being associated with the fibre. At the centre of these claims is the anti-bacterial performance attached to the fibre. While antibacterial material has been identified in bamboo (Nishina et al 1991), similar studies on regenerated bamboo fibres have not been found. Furthermore the sustainable nature of bamboo provides it with two very marketable properties. A further characteristic of bamboo is the natural sheen that the fibres possess. This makes it a very desirable fibre for some applications. There are claims that the anti bacterial properties of the natural material remain after the chemical processing to provide the final fibre.

It is not possible to dispute the fact that bamboo is sustainable. It is claimed to be among the world’s fastest growing plants (Jinhe Fu 2001). Bamboo is well known as a habitat for the giant panda, associated with the World Wildlife Fund, but optimum varieties for fibre production are not those chosen by the panda. In general terms the selection of bamboo as a source of raw material for the production of fibres does have a strong element of sustainability. The plants will regenerate within a 3 to 4 year period and this compares favourably with trees, the standard source of cellulose for regenerated cellulose fibres, which are grown of approximately a ten year cycle. Furthermore the growing of bamboo generates a greater amount of oxygen than an equivalent area of trees (Sastry 2002).

Supplies of natural bamboo fibre are extremely limited and it is unlikely that these are or will be available in sufficiently large quantities to be able to satisfy the demands of the corporate clothing business. Bamboo fibre that is on the market is regenerated and has been produced using the viscose process (Saravanan & Prakesh 2007). As such it will have been trough several aggressive chemical processes before it emerges as a textile fibre. It may be legitimately argued that the control of these processes is far more stringent than when the viscose process was introduced around one hundred years ago and therefore the process has less of an environmental impact.

The bamboo fibres produced have properties that are the same as viscose fibre. Applications of bamboo fibre within the corporate clothing sector can therefore replicate those where viscose is currently used. The porous nature of the fibre provides it with ideal moisture management properties.

Currently bamboo fibre is finding applications in areas such as towelling where the combination of natural moisture absorption and antibacterial properties makes if appear to be an idea fibre for this type of application.

7.2.2 Nettle (*Urtica dioica*)

With a history of use dating back to the bronze age, nettle fibres potentially offer a natural alternative in some areas of corporate clothing. Nettle fibres are cellulose based natural fibres that can offer many of the advantages of cotton. Nettle fibres had been used in the UK for making strong, durable cloth up until the second half of the nineteenth century when alternative cheaper imports of cotton replaced this application. Currently fibres labelled as “nettle” can come form a range of plants that are considered to be within the nettle family and this can include fibres such as ramie. Within Europe there is considerable interest for fibres derived from the stinging nettle (*Urtica dioica*) and it is these fibres that show an ability to break into the clothing market.

The potential of using a “home grown” source of fibre coupled with the durable nature of the nettle based fabrics was a deciding factor that prompted research between the World Wars. Although much of the initial research was directed towards improving the yield from the plants, recent years have seen attention given to the extraction process and the whole supply chain.

Nettle fibres are known to have a high strength (Bodros & Baley 2008) and the projected use of nettle during the Second World War was into fabrics that required good durability. The hard wearing properties that are associated with nettle make it eminently suitable for applications where durability is crucial. Jackets and suiting fabrics offer ideal applications for the fibres where best use is made of the fibre properties. Blends of nettle and cotton are available and are found in applications such as sheeting and similar items of household textiles. It is most unlikely that nettle fibres would be suitable for applications in light weight fabrics such as those used for shirting although blended with cotton the coarse nature of the fibres would be masked to some extent.

Nettle fibres are frequently found blended with cotton and this combination can offer some positive options at the end of life. Separation of the two fibre types is not a realistic option however with both fibres being cellulose based reuse of the fibres as a raw material for the manufacture of regenerated cellulose fibre (viscose or lyocell) is a possibility.

Nettle fibres appear to offer enhanced fire retardant properties to fabrics, even the performance of wool which has an inherent fire retardant nature is improved when blended with nettle. The potential to incorporate a fibre with natural fire retardant properties into blends may reduce the reliance on chemical treatments

Currently the one major obstacle to the introduction of nettle on a wide basis is the limited extent of the UK and indeed European, based supply chain. This includes both the cultivation and processing. Within the UK the amount of nettle fibre that is currently being produced is extremely limited and all production is being used within the upholstery sector where it is blended with wool and is used mainly for seating in public and corporate applications. Even production off-shore is limited and production is accounted

7.2.3 Flax (*Linum usitatissimum*)

Flax is among the oldest of natural fibres that has been used by mankind for clothing. Records dating back several millennia show that flax has been used in clothing textiles. Flax is frequently encountered as linen fabric where the hard-wearing nature of the fibres is used to advantage, generally in woven fabrics.

Flax is an example of a bast fibre, the fibres in the stem of the plant being located around the outside of the stem. They are present as bundles of individual fibres that are bound together with a variety of complex materials such as pectin and lignin. The fibres are removed from the plant using a retting process that provides long strands of fibre bundles that are then processed into linen. Recent developments have however investigated the potential of improving the degree of separation whether this by chemical or physical means. These highly separated fibres can then be processed into finer quality fabrics of blended more readily with other fibres such as cotton, to provide useful blends.

Like many natural cellulose fibres, flax does suffer from a tendency to crease easily and this then requires suitable treatment during laundering to minimise any creasing effects. The moisture regain properties are not unlike cotton and it therefore finds applications in blends with cotton. In this form the resultant yarn has all the benefits of cotton with the increased durability that comes from the use of flax.

Currently within the UK the supply chain bringing flax from the fields to the finished garments is extremely limited and it is essentially at the stage where the processing is being re-established. The effect of this is that the widespread introduction of UK grown and processed flax into the corporate clothing market is realistically some time away. Far Eastern supplies may be more plentiful.

8 Laminating and coating

Although simple fabrics will be able to meet the requirements of the majority of garments, outerwear which needs to provide additional protection, requires specialist materials. It is in these applications that laminated and coated fabrics come into their own. The basic fabric provides much of the structure for the garment and the presence of an additional layer either directly as a coating or in the form of a laminated layer will be designed to provide the protection.

The protective layer of these fabrics needs to be able to keep water out while remaining breathable to ensure wearer comfort. Natural fibres are generally not used in coated or laminated fabrics, where the majority of the fibres will be polyester or nylon. These fibres will provide the physical properties such a garment requires and will not absorb significant levels of moisture. The outer layer of these fabrics will often be based on polyurethane and in some cases polytetrafluoroethylene (PTFE).

These combinations of compounds do not represent the easiest of materials to dispose of at their end of life. Incineration maybe one option however PTFE can generate toxic by-products if the incineration conditions are not ideal and there will inevitably be fluorinated material present in the exhaust gas stream which can cause problems. The materials are also extremely difficult to handle using other end of life processes and there is almost an inevitability that these will end up as landfill. With current technology it is difficult to see how these products can be substituted by others and still provide the combination of properties required for the designated application.

9. End of Life Opportunities

End of life is usually considered to be the point at which a garment is taken out of service because it is no longer serviceable or it has reached then end of its designed lifetime. At this stage there are several possible means whereby the garment can be removed from service. The end of life opportunities are being reviewed in detail elsewhere and it is therefore not the intention of this report to delve into these in any great depth but to allude to the different approaches that may be adopted.

The wide variety of fibres, fabrics and garments that are used in corporate clothing means that a single end of life disposal process cannot be adopted. Homogeneous fibre content in a fabric/garment provides a better chance of being able to utilise the fabrics.

The options that are available for disposal will include landfill. This is seen as the last resort when little else can be done with the fabric. Blended yarns and especially those that have been coated and laminated will face serious barriers to easy reuse and will often be directed towards landfill.

The ideal scenario is to be able to reuse, as this will require no further processing to extend the life of the garment. Recycling will enable the fabric of the garment to be used for some purpose which may or may not be the same as in the original garment.

Disposal through composting requires the fibres to be degradable and is essentially only applicable to cellulosic fibres. Under industrial composting conditions many of the cellulosic fibres will be completely composted with a few weeks. Although wool can biodegrade the timescales are significantly longer and this is not seen as a sensible option for disposal.

Incineration is always an option as a means of disposing of organic materials. This approach does need to be given careful consideration since toxic by-products may be produced during incineration

10 Barriers to reduced use of land fill.

The options taken at the end of life will be influenced by corporate policy; are new issues given in return for the used garments or does the wearer keep the old cloths. Discussions indicate that both of these options are used within the corporate clothing sector. There is therefore more than one difficulty to be faced when attempts are made to reduce the level of textiles sent to landfill. The companies that opt for leaving the old clothing with the wearer will rely on them to select the way in which the cloths are dealt with at the end of life. This will often result in the garments being sent to landfill with general household refuse. Despite the increasing use of road side collections of domestic materials for “recycling” there is still a high proportion of used textiles that go into the general waste and will be directed towards landfill. The use of available roadside collection schemes for used corporate clothing is likely to be small.

When replacement garments are issued on an exchange principle then there used garments will be held by the corporate entity issuing the garments. The selected end of life options taken will then depend very much on company attitudes. It could be argued that the supplier could and maybe should, undertake a similar exchange process, taking away the used garments for recycling. With all the garments in a central location the route to recycling should be easier. Despite this there are difficulties to be faced relating to how to recycle the garments. The onus is now on the corporate body to recycle correctly.

10.1 Garment labelling

There are legal requirements that govern the labelling of garments however these are often on printed labels and the information fades during service. Therefore at the end of life identifying what the constituent fibres are in a garment can be difficult. Often the labels identifying the fibre content are not the only ones present. There could be size information, stock identification, care instructions, manufacturer’s identity. With numerous labels it then becomes a case of search for the correct label and try to read the data on it.

These difficulties may lead to reluctance to become committed to an end of life programme that reduces the volume of material that is sent to landfill. It is therefore apparent that some form of readily identifiable label is required that clarifies the route to be adopted. The Royal Mail, faced with this problem, has introduced a labelling system which incorporates a bar code so that the “end of life” options are easily identified.

Whether the labelling scheme should be specific to a company or is a sector wide standard is something that needs consideration. An in depth analysis of the labelling issues is being undertaken elsewhere and will be reported separately.

10.2 Fibre identification

With faded labels and the fibre content no longer clear, selecting the optimum end of life opportunity becomes difficult. Identification of the fibres may be the only way forward. This is something that needs consideration. Many options are available and some are outlined within this report. These range from simple microscopy to more elaborate spectrometry procedures. While these various analytical approaches to fibre identification will enable the fibres to be identified, a more robust form of labelling would appear to be a better approach. This would overcome the need for any form of instrumentation to be available for testing and eliminate the need for training to be undertaken.

10.3 Education

Inevitably “education” provides a barrier to decreased use of landfill. Designers, suppliers and users must become more aware of the environmental impact that fibre choice has. People are in general becoming more aware of the need to reduce the amount of material that is sent to landfill. There will always be a hard core of resistance while the individual is responsible for directing the clothing to the correct stream at the end of life. There will always be the “my little bit won’t make any difference” mentality among some users that will act as a barrier to decreasing the amount of material that goes into landfill. Transferring this responsibility to the corporate supplier overcomes this difficulty. In the longer term each users must become more aware of the need to avoid landfill and acknowledge that they must play their part.

10.3 Collection systems

There is much debate currently over the eco-friendly credentials that are attached to road side collections. There can be little doubt that the carbon emissions associated with running collection vehicles around streets is not helpful when trying to reduce the overall carbon footprint associated with textiles. However with a corporate end of life recycling scheme this can be addressed by the use of centralised collection points. With such a system the garments can be divided into the different end of life streams and suitable transport options organised. Until centralised collection is standard it is unlikely that each user would put in the effort to ensure that used garments go into the correct end of life stream.

11 Fibre identification

While product labelling should ensure that the fibre content within a garment is as stated on the label, there are occasions when it is necessary to confirm the identity of the fibre. Specialist test houses can perform the necessary testing however some simple tests can be carried out "in house" with even the most rudimentary equipment. A selection of test procedures is outlined in the following sections as a guide to fibre identification. It is not intended to be a definitive commentary on the tests and the results. These are best covered in specialist texts.

11.1 Burning

Burning tests can be used as an initial test in fibre identification. Principally these tests will distinguish between cellulosic and protein fibres but can be useful as an aid to identifying other types of fibre. For commercial identification other tests should be performed to confirm the indications obtained from burning tests.

The tests are carried out by slowing introducing a few fibres into a naked flame. Observe the reaction of the fibres, do they melt, burn or char. It is also important to make a note of any odour that may accompany the fibres when removed from the flame. Once the residual ash has cooled examine to see if it is easily crushed, has formed a solid bead or any other characteristics.

Approaching flame	In flame and after removal	Fibre classification
Does not melt or shrink from the flame	Burns with some sputtering leaving behind an inflated friable black ash. There is a smell of burning hair associated with the test	**Protein fibres**: wool and silk
No melting	Burns rapidly leaving behind a soft grey ash. Smells like burning paper	**Cellulosic:** cotton
	Quick burning, smelling of burning paper leaving with very little ash	**Cellulosic**: viscose

	Burns rapidly leaving behind a hard black bead. Smells like burning paper and vinegar	**Cellulosic**: acetate
Retracts from flame and melts	May burn and if this is the case usually self extinguishing	**Thermoplastics**
	Burns with difficulty. Melts and drips leaving behind a hard fawn coloured bead. Often a fishy smell or smell of celery associated with the test.	**Thermoplastics**: Nylon
	Burns with a luminous sooty flame, leaving behind a hard black bead. The smell is often aromatic or fruity.	**Thermoplastics:** Polyester
	Burns, melts and leaves a white bead. Can have a waxy smell associated with it.	**Thermoplastics:** Polypropylene
Do not melt	Burns readily with a smoky flame leaving a crisp black ash. Acrid bitter smell associated with the burning.	**Acrylics**
Melts	Glows in the flame melting at higher temperatures and forming hard, clear beads. No smell associated with it.	**Glass**

11.2 Density

Fibre density can often be used as a guide to the identity of a fibre. Using liquids with various densities will enable the density of a fibre to be estimated. Care must be taken to ensure that any liquid used does not react with the fibres being tested.

Fibre	Density
Cotton	1.54
Wool	1.32
Flax	1.54
Nettle	C 1.5
Viscose	1.50-1.52
Lyocell	C 1.5
Modal	C 1.5
Polyester	1.38
Nylon	1.14

These data are given as a guide to the fibre density, however the application of finishes can affect the density and this must be considered if using this test method.

11.3 Microscopy

Examination of fibres using optical (or electron) microscopy can provide evidence of the fibre types that are present. Differences in the fibre cross section and the nature of their surface can act as guidance to the origin of the fibres. Some fibres have characteristic appearances that make their identification easy, for example the scales that are present on the surface of wool fibres, others need a little more investigation.

Simple optical microscopy techniques will look at the fibres longitudinally and in cross section. Specific details of preparation techniques and microscopy operation are beyond the remit of this report and widely published, for example by the Textile Institute (Textile Institute 1975). Scanning electron microscopy provides similar images and can show more surface detail. A range of fibre cross sections is shown in figure 13 to 18 and longitudinal images in 19 to 22.

Fibre cross sections of fibres produced using melt spun technology, fibres such as polyester, nylon and lyocell all tend to have smooth surfaces and circular cross sections It is often difficult to distinguish these apart based on simple microscopy. The fibres are all likely to contain a delustrant and therefore this will not assist in the fibre identification. Other more specialised optical microscopy techniques are required to be able to distinguish between these fibres. Dispersion staining is one such technique (Coyle et al 2002).

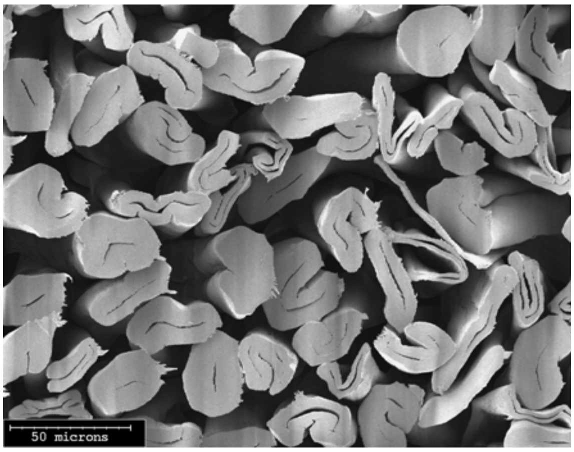

Figure 13 Cotton (cross section)

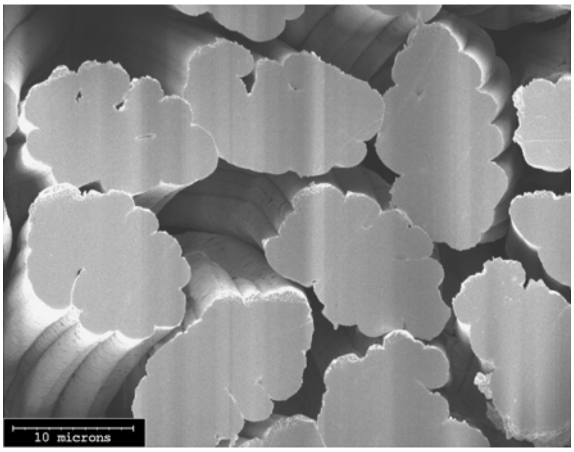

Figure 14 Viscose (cross section)

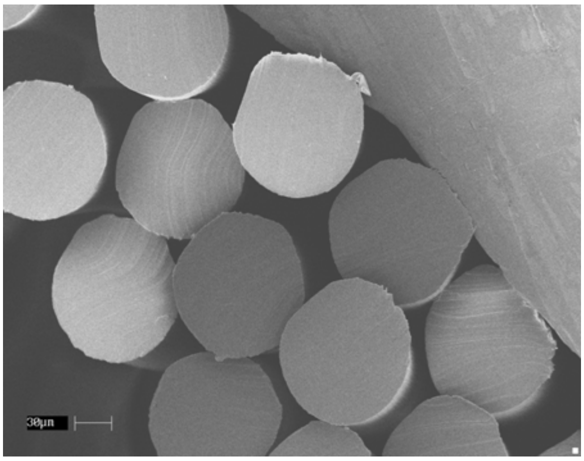

Figure 15 Polyester (cross section)

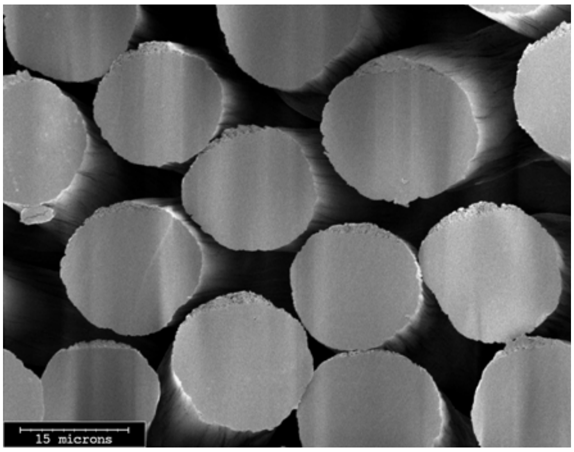

Figure 16 Acrylic (Courtelle) (cross section)

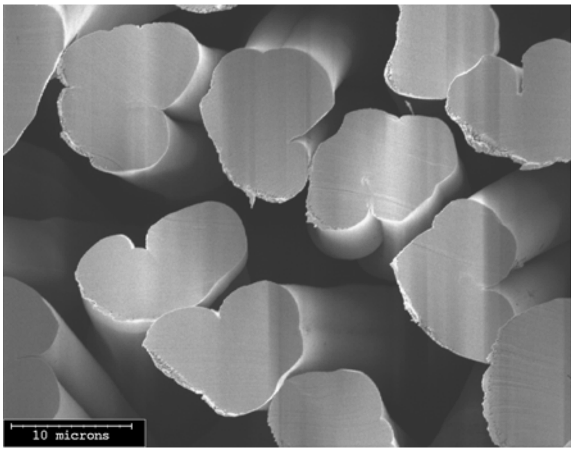

Figure 17 Modal (cross section)

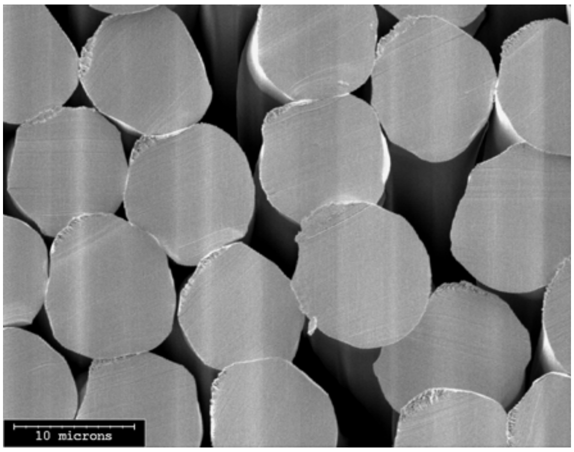

Figure 18 Lyocell (Tencel) (cross section)

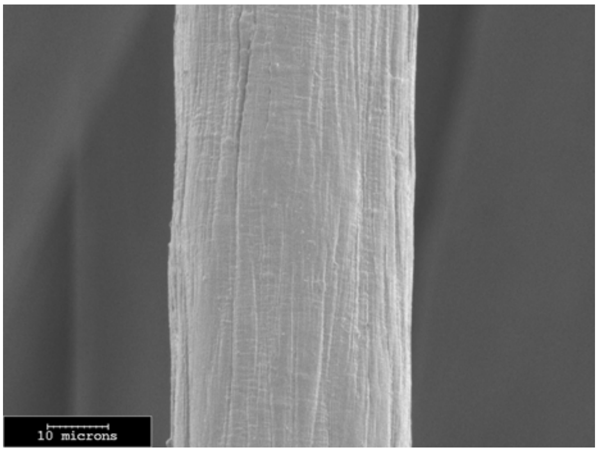

Figure 19 Surface of acrylic fibre

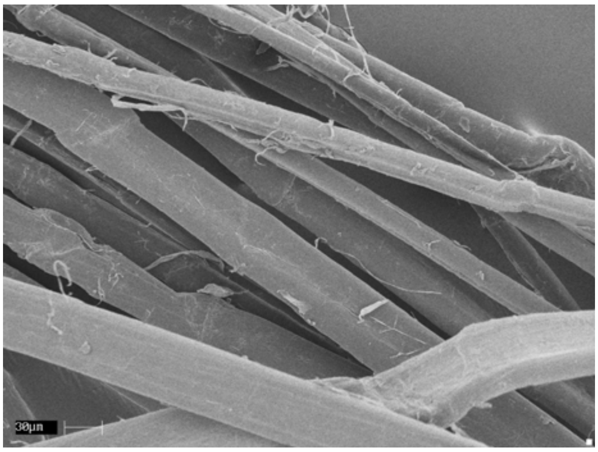

Figure 20 Surface of flax fibre

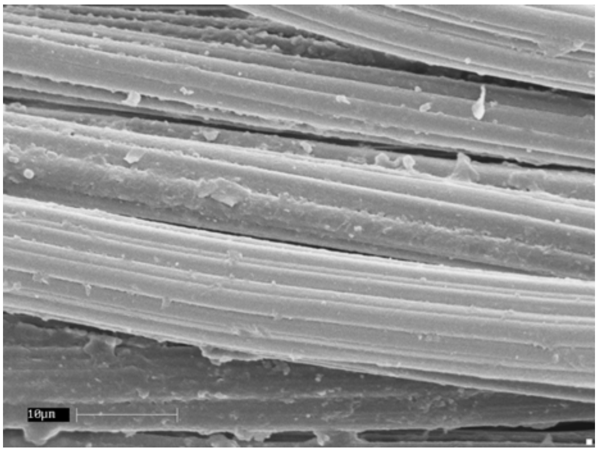

Figure 21 Surface of viscose fibre

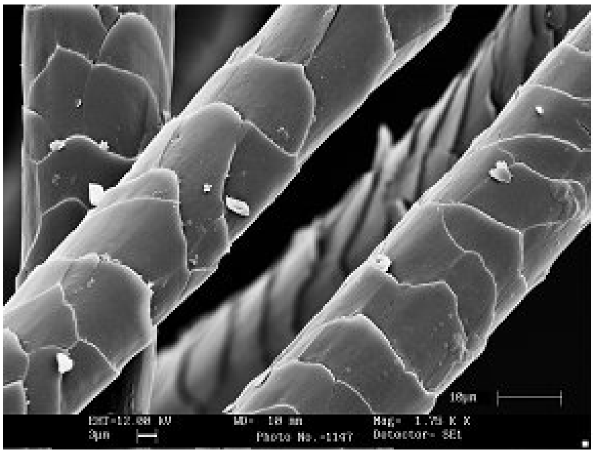

Figure 22 Surface of wool fibre

11.4 Staining

When instrumental techniques are not available, the use of staining techniques can be useful. A series of stains, known as Shirlastains, is a series of mixed dyes that are differentially absorbed by different fibres. These tests can only be applied to undyed fibres and any dye must therefore be stripped prior to testing. Details of the test procedures and observations made during the tests are supplied with the stains and are not considered within this report.

stain	application
Shirlastain A	Used to distinguish between natural and regenerated cellulose fibres
Shirlastain C	Used to distinguish between types of cellulose fibres
Shirlastain D	Distinguishes between raw cotton and viscose
Shirlastain E	Used for synthetics

(*Note*: Shirlastain fibre identification stains are obtainable from SDL Atlas ltd., PO box 162, Crown Royal, Shawcross Street, Stockport, SK1 3JW tel 0161 480 8580)

11.5 Reaction to solvents

Cellulosic fibres will react rapidly with cuprammonium hydroxide, dissolving to leave behind no residue. Cross linking treatments, such as applied to Tencel A100, to make the fibres more resilient and impart a higher level of "easy care" generally prevent dissolution from tacking place. The fibres will swell significantly but do not show signs of dissolution.

Fibres produced from synthetic polymers can be dissolved using a range of different solvents.

11.6 Melting point

Determination of the melting point of the fibres is really only useful for the melt spun polymer fibres including polyester, polyamides and poly olefins. It can be successfully used to determine between different grades of the poly amides and poly olefins. Measurements can be carried out in several ways. Fibres can be melted on a hotplate fitted with a suitable thermometer. Simple melting point apparatus are also available along with hot stage microscopy. More sophisticated thermal analysis equipment is however available and can be used for very accurate work. Specific test details are not within the scope of the current report.

fibre	Melting point
Polyethylene Low density	105-115
Polyethylene high density	120-130
Polypropylene	160-170
Nylon 6	215-220
Nylon 6.6	250-260
polyester	255-260

11.7 Spectroscopy

A range of spectroscopic analysis methods are available but often require instrumentation not available in many testing laboratories. These tests will generally rely on the molecular arrangements within the polymer of the fibres and gives rise to the ability to examine fibres using infra-red (FT-IR), raman and nuclear magnetic resonance (NMR) spectroscopy. The use of x-ray crystallography is another means of fibre identification.

It is not the purpose of this report to provide a comprehensive data base of spectra from these techniques which will available to practitioners of these technologies. However for the purpose of illustration selected infra-red spectra are shown in figure 14 to demonstrate the potential. Within this range of techniques it possible to distinguish between the various forms of cellulose to ascertain whether it is from natural or regenerated sources and further distinguishes between the types of regenerated cellulose. The sharpness of the peaks being one factor that allows differentiation between the various cellulose fibres.

The examination of acrylic fibres using FT-IR spectroscopy can also provide a means whereby the manufacturer can be identified. It is therefore possible to confirm that fibres claiming to be a specific type can be verified.

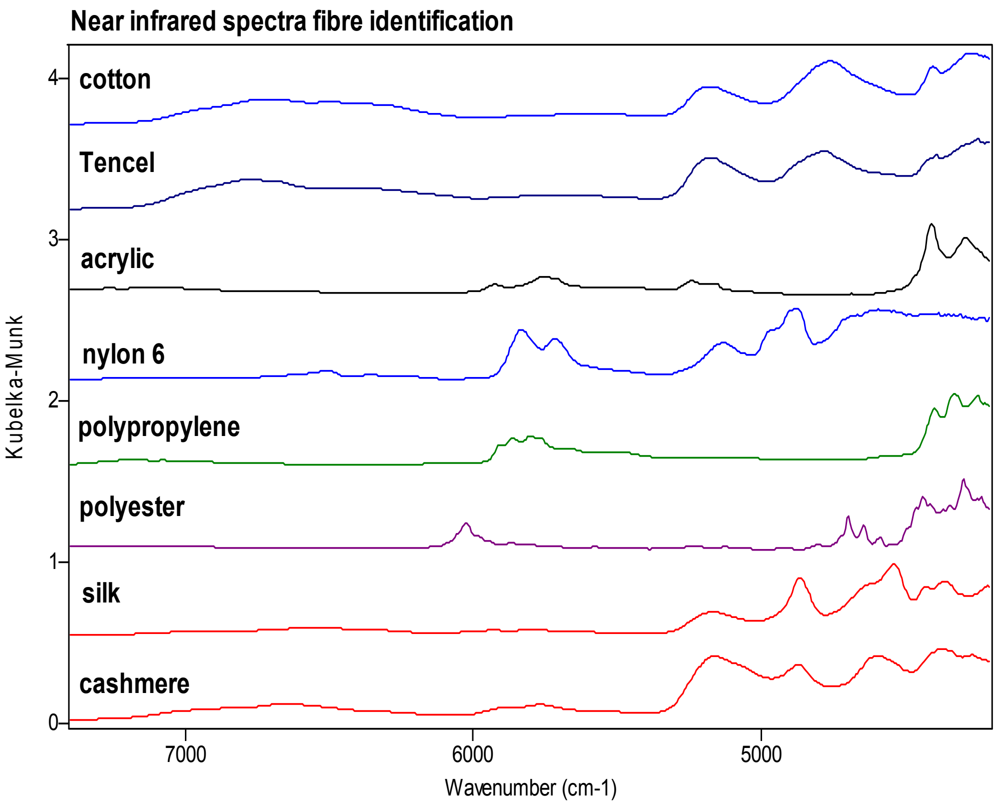

Figure 23 Typical FT-IR spectra of fibres

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13 Fibre/Fabric Database.

The rationale behind the study has been to provide a means whereby current and potential fibres/fabrics for use in the corporate clothing sector, can be compared. Any such comparison will be dependent on a multitude of factors that will influence the choice. Although application is the foremost factor that will be influencing the material selection, service life and cost will also play an important role.

The information contained within the following data sheets is an attempt to draw together some of the salient points that may be of interest at the specification and design stage without trying to be exhaustive.

De Montfort University produces these data on the fibres/fabric groups and blends on a non exhaustive basis. De Montfort University therefore makes no representation, express or implied that any of the fibres/fabric groups or blends will be unaffected by other treatments or processes. Users of these data must address the possibility of any health and safety issues that may arise personally.

13.1 Cotton data sheet

13.1.1 Property summary for cotton

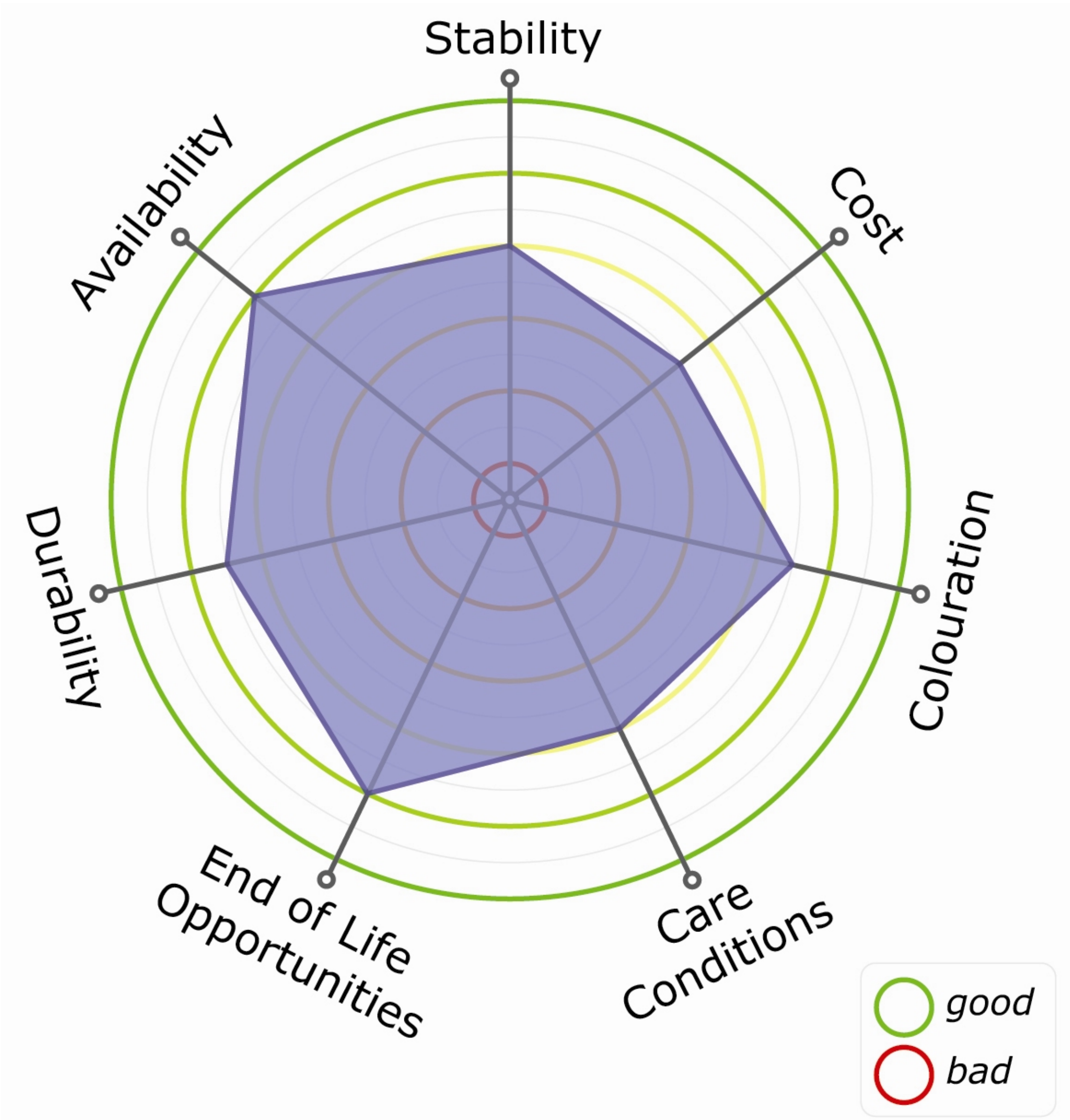

Figure 24 Property summary for cotton.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.1.2 End of life Opportunity summary for cotton

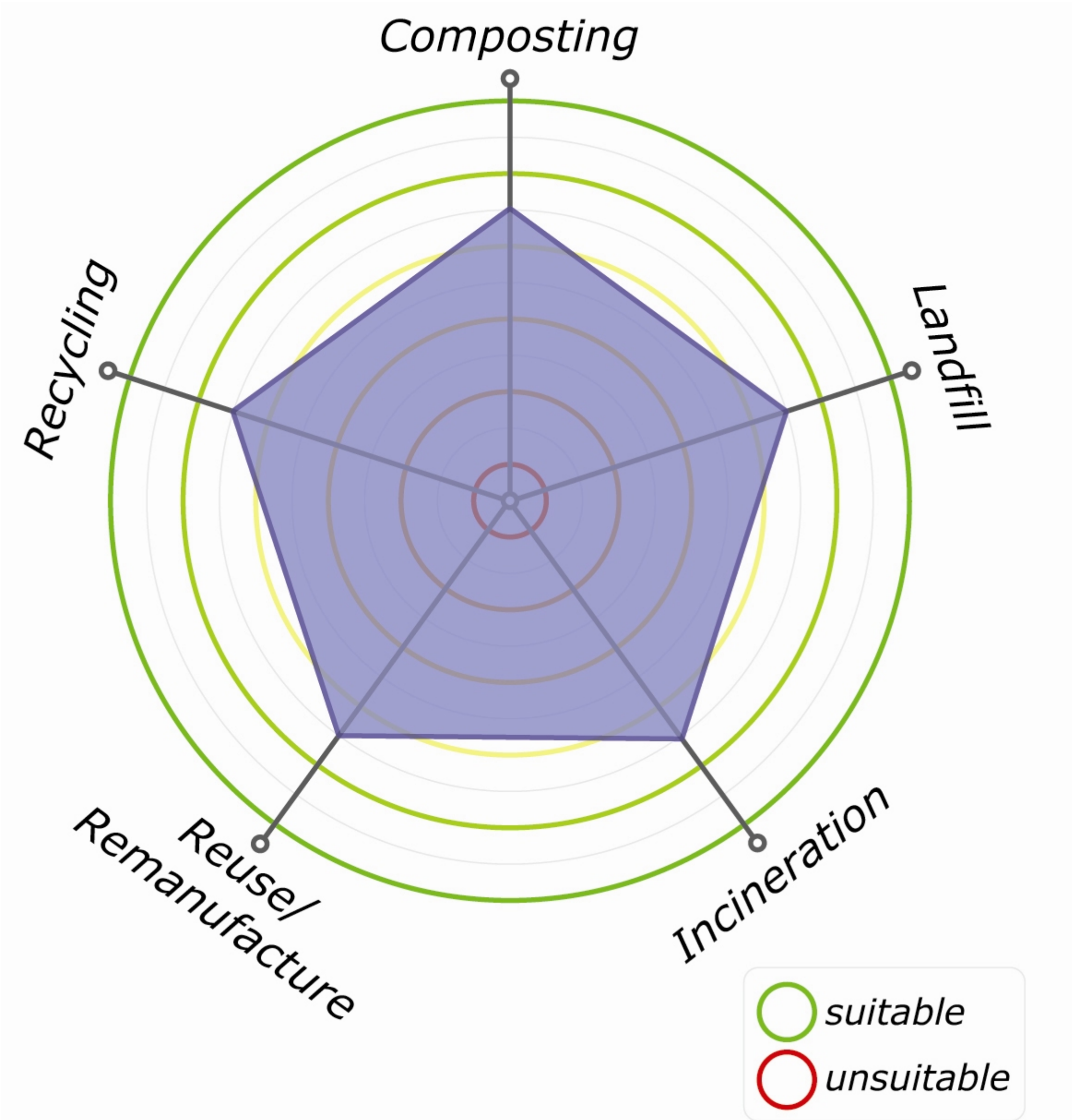

Figure 25 End of life opportunities for cotton.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.1.3 Data sheet for cotton

	COTTON
General	Natural cellulosic fibre
General	Cotton is a natural cellulosic fibre that is characterised by the flat ribbon like structure that has a tendency to twist. It is only available as staple fibre. Naturally near white, organic and "green" cotton are also available. The soft handle and moisture regain properties make it an ideal fibre for use in clothing. Cotton requires extensive chemical intervention and high levels of irrigation during cultivation.
Available as:	Wide range of woven and knitted fabrics
Available as:	Can be supplied as a single fibre yarn but will often come as a blend with other fibres. The compositions of the blends can vary considerably both in terms of the other fibres used in the blends and also the percentage of cotton in the blend. Generally available as a woven fabric, it can come in a range of weave patterns that will includes, simple weave, hopsack and twill. Fabrics can be supplied in a wide range of fabric weights encompassing 145 to 300 gsm
Colouration	Readily bleached and dyed
Colouration	It is recommended that hydrogen peroxide bleaching is used as a preparation of the fibre irrespective of the ultimate shade as this route removes most of the extraneous matter present. This will facilitate better levelling during the dyeing process. Cotton for corporate wear can be dyed with reactive dyes or in some cases direct dyes. If the clothes are to be used for work wear more durable colouration is necessary and reactive dyes, vat dyes or sulphur dyes would be the selection of choice. Use of organic cotton would require specialist bleaching and dyeing processes in order to retain the organic cotton label.
Dimensional Stability	Generally stable, especially woven fabrics.
Dimensional Stability	Affected by the fabric construction and weight. Woven cotton fabrics show a greater degree of dimensional stability during laundering than knitted.

Resistance to pilling	Pilling resistance will be affected by the form of the fabric and also the way in which the yarns have been manufactured. Some spinning techniques result in yarns with a hairy appearance and these will be more prone to pilling.
Moisture regain	Moderate moisture regain, up to 11%
Moisture regain	Moisture regain @ 65% R.H. 20°C 7 to 11%
Care information	Stable under industrial laundering conditions, may be boiled.
Care information	While cotton can be easily laundered at high temperatures, these should only be used for heavily soiled garments. Dyes have a tendency to bleed and suitable separation during washing should be encouraged. Chlorine based bleaches can be safely used on cotton, although dyed fabric should use a colour safe bleach. Tumble-drying requires a high temperature setting. Cotton is prone to becoming creased during washing and this will requires the use of a hot iron during pressing. Cotton can be treated with a crease resistant finish therefore when laundering instructions may recommend lower heat settings during drying and ironing
Applications	Suitable for use in a wide range of garments
Applications	Cotton is widely used in homogeneous and blended yarns. Polyester cotton is the most common blend and widely used if easy care fabrics which require a combination of the natural fibre properties associated with cotton and the durability of polyester. Fabrics can be supplied in a wide range of fabric weights encompassing 145 to 300 gsm
End of life Possibilities.	Can be disposed of using all end of life opportunities

End of life Possibilities.	Although cotton is biodegradable it also has the potential to be reused in other ways. Re-use in most ways will be dependant upon the removal of corporate identities such as logos. Some applications will also require the removal of fastenings such as buttons and zips. As complete garments, the reuse in similar roles, for example in third world countries, offers one possibility. In fabric form it can be recycled into wipes for use in a variety of industrial sectors and shredded to be used as mattress infill or into insulation for buildings. Cotton can also be used as a source of raw material for the manufacture of regenerated cellulose fibres either through the viscose or lyocell processes.
Eco aspects	Key environmental impacts of the cultivation of cotton include:
	• Impacts of industrial scale cotton growing such as reduced soil fertility, soil Stalinisation, loss of biodiversity and water pollution etc.
	• Massive pesticide use on the cotton crop causing problems to land, animals and severe health problems in humans arising from exposure to acutely toxic pesticides.
	•The most widely used groups of pesticides on cotton are insecticides and have been classified by the World Health Organisation as 'moderately hazardous'. However, some insecticides that are widely used, especially in developing countries, are classified as 'highly hazardous'; these are generally acutely toxic and are nerve poisons.
	•Cotton fibre production also requires large quantities of fungicides, herbicides and defoliants. Large amounts of synthetic fertilisers (often based on nitrogen compounds) are also used and can result in nitrate contamination to water. Fertiliser pollution of water can cause accelerated growth of aquatic plants and algae. Such accelerated growth (eutrophication) can deoxygenate the water to a state in which it cannot support animal life.
	• Major water consumption in crop cultivation, ranging from 29000 litres in Sudan to 7000 litres in Israel per kg of cotton fibre (approx 2 pair of trousers).

Cost scope (economic impact)	
Common trade names	not applicable
Alternatives	The range of regenerated cellulose fibres available can often be used as suitable alternatives to cotton. Other natural cellulose fibres, such as flax, can also be used as a cotton substitute
Specialists	Carrington Career & Workwear Ltd, Market Street Adlington Nr Chorley Lancashire PR7 4HJ Tel: +44 (0) 1257 476 850 Fax: +44 (0) 1257 476 863 Email: info@carrington-cww.co.uk

13.2 Wool data sheet.

13.2.1 Property summary for wool

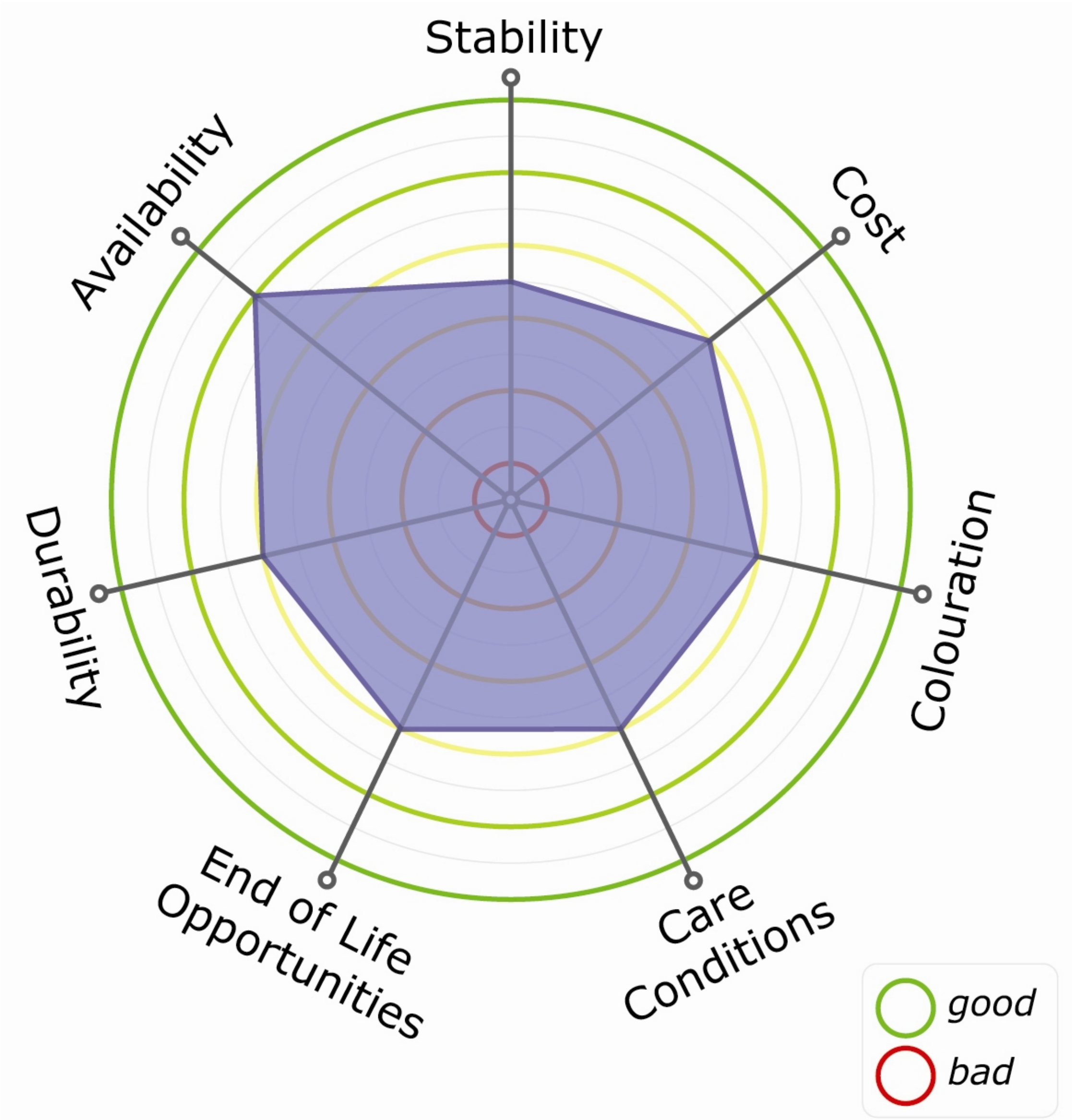

Figure 26 Property summary for wool.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.2.2 End of life Opportunity summary for wool.

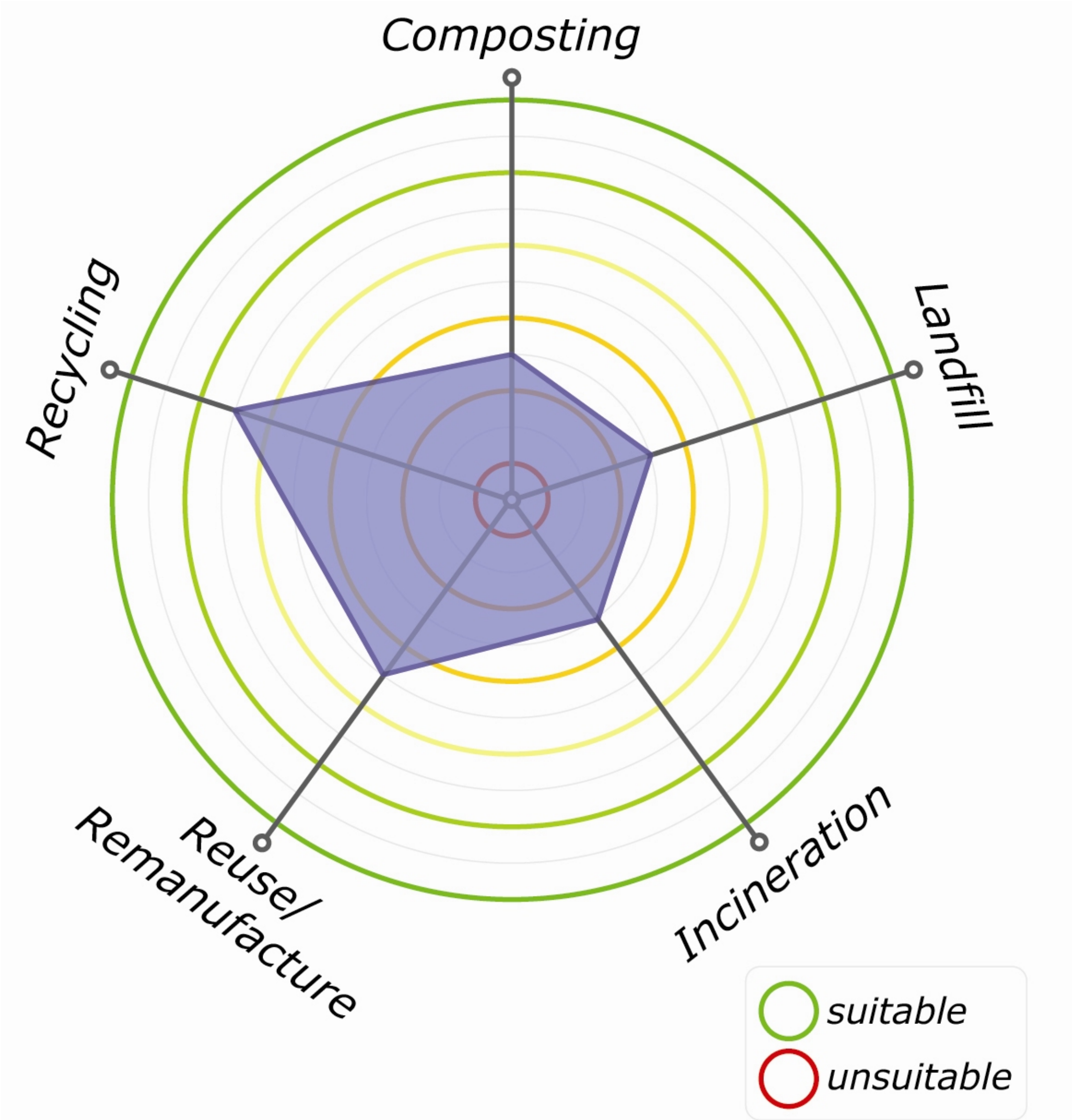

Figure 27 End of life opportunities summary for wool.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.2.3 Data sheet for wool

	WOOL
General	Natural protein fibre
General	A Natural Fibre from the fleece of sheep. The quality of wool will be very dependant on the source with the best quality fibre coming from Merino sheep. Woollen fabrics are versatile and possess a soft handle giving the wearer a sense of comfort. Naturally crease resistant wool is a good insulator, making it an idea fibre where thermal properties are considered to be important. Treatments are often applied to wool to improve the resilience during cleaning.
Available as:	Available as woven and knitted and in blends
Available as:	As a staple fibre wool can be spun into a range of yarns and converted into knitted or woven fabric. Wool is often blended with polyester for use in suiting materials where 55% polyester 45% wool blends are used. Weights of the fabrics used are typically 290-350gsm, with the lighter weight fabrics often containing up to 2% lycra.
Colouration	
Colouration	Standard bleaching treatments are not applicable to wool, special processing is required to bleach wool and advice should be sought from specialists in dyeing and finishing wool. Sodium hydrosulphite is widely used to bleach wool Wool can be readily dyed using a wide variety of dye types and dyeing conditions.
Dimensional Stability	Can be prone to shrinking especially when knitted.
Dimensional Stability	Can be poor if cleaning is carried out incorrectly. Knitted fabrics are more prone to shrinkage than tight woven fabrics Poor treatment during washing can lead to serious changes in dimensions. These are caused by the scales of the fibres locking together and preventing the structures reverting to the original dry state. Dry cleaning prevents the shrinkage from occurring.

Resistance to pilling	Generally resistant
Resistance to pilling	Wool has good resistance to pilling. It has good abrasion resistance and is frequently used as a standard surface in tests for other fabrics.
Moisture regain	High regain up to 20%
Moisture regain	Wool will react rapidly to changes in humidity and the level of absorbed moisture will change. This will be accompanied by the absorption or release of energy. Typical regain values are 15-20%.
Care information	Care need when laundering, dry cleaning preferred
Care information	Woollen garments will often be "dry clean only" to prevent damage to the clothing. These instruction should be followed. Wools are often treated with chemical finishes to enable them to be hand washed, but care should be taken to avoid damage to garments
Applications	Wide range of garments
Applications	Wide range of applications exist for wool and wool blends. The thermal properties associated with wool make it idea for sweaters and warm clothing. Used in blends it is often used in suiting. Examples of use - sweaters, dresses, coats, suits, jackets, trousers, skirts, blouses, shirts, hosiery, scarves
End of life Possibilities.	Suitable for many end of life opportunities, though very slow to compost
End of life Possibilities.	Re-cycled for example to Third World countries. Knitwear that can not be used for the above (contains holes, soiled) would go in to making shoddy or felts used in bedding and automotive applications. Woollen knitwear would be used for such items as making hanging basket inners, insulation for sewers etc.
Eco aspects	Key environmental impacts of producing wool include:

	• Pesticides used on sheep which cause harm to human health and water courses both on the farm and in subsequent downstream processing. Traditionally sheep have been dipped to control parasite infection.
	• The two pesticides most commonly used for dipping are organophosphates and pyrethoids. Exposure to the former is linked to severe nerve damage in humans (notably in the case of sheep dip in farmers). This has led to an increased use of the latter which has given rise to a significant growth in incidences of water pollution as pyrethoids are one thousand times more toxic to aquatic life than organophosphates.
	• Effluents arising from wool scouring – which are significant in terms of their pollution potential to both water and land (in the form of wool grease sludge). Raw wool like all other natural fibres contains many impurities. It is scoured at hot temperatures in an aqueous solution of sodium hydroxide (caustic soda) and detergent to emulsify the grease. The process produces an effluent with high suspended solids content, high temperature, and high BOD.
Cost scope (economic impact)	
Common trade names	
Alternatives	
Specialists	Australian Wool Innovation Ltd., Little Lane, Ilkley West Yorkshire LS29 8UG United Kingdom Tel +44 1943 601 555 Fax +44 1943 601 521

13.3 *Viscose data sheet.*

13.3.1 Property summary for viscose.

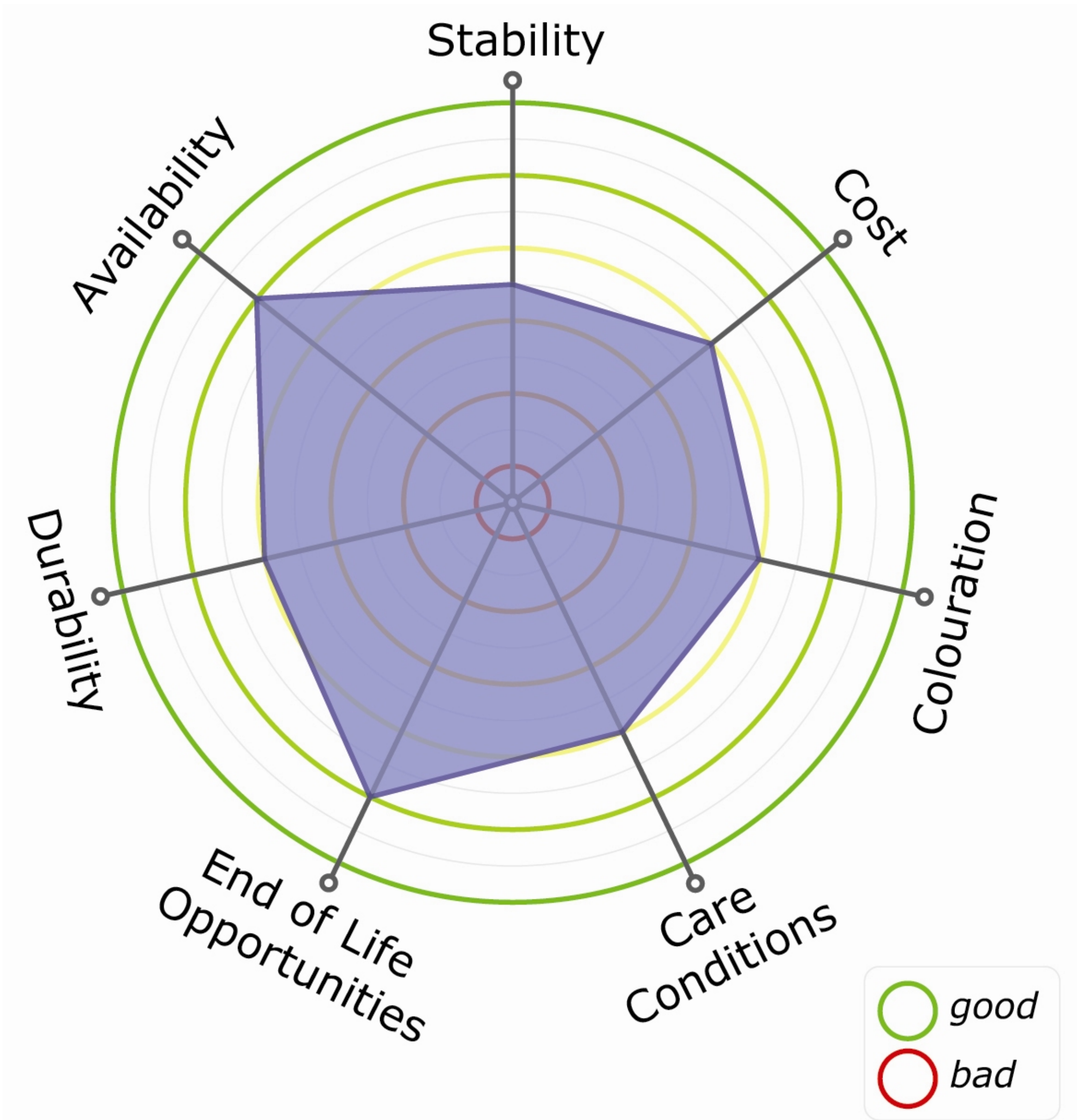

Figure 28 Property summary for viscose.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.3.2 End of life Opportunity summary for viscose

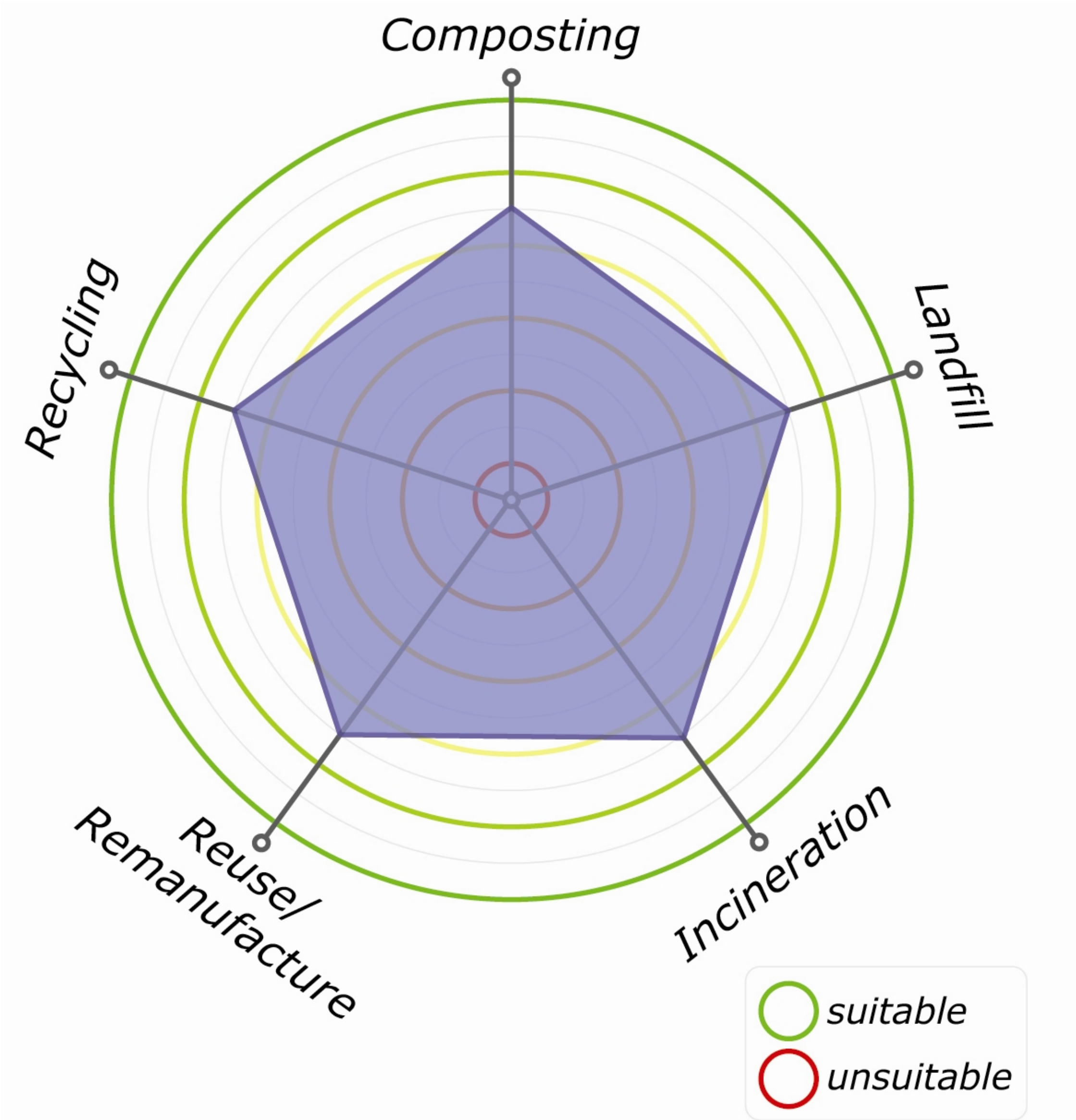

Figure 29 End of life opportunities for viscose.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.3.3 Data sheet for viscose.

	Viscose
General	Regenerated Cellulose fibre
General	Viscose fibres are a form of regenerated cellulose that are manufactured through a complex chemical process. Converted into a series of intermediate cellulose compounds, the final spinning process regenerates cellulose from a cellulose xanthenes dope. Involving strong sodium hydroxide and sulphuric acids as well as carbon disulphide, there are inevitably environmentally concerns surrounding the process. Latest technology does however attempt to address these issues.Generally viscose fibres have an irregular round cross section with a porous internal structure. It is however possible to spin viscose with a flat cross section such as Viloft® which provides the fibre with improved moisture absorption. Viscose is a strong and durable fibre which is abrasion resistant yet soft to handle and has good drape properties. It is extremely adsorbent and breathable which combine to make garments made from the fibre comfortable
Available as:	Wide range of woven and knitted fabrics
Available as:	Fabrics containing viscose fibres can contain both continuous filament and staple. Lightweight woven fabrics utilising continuous filament viscose find applications in linings for suit jackets and skirts. Staple viscose fibres are often converted into non-woven fabrics where there are used as interfacing in constructing garments. They are available as a wide range of weights and bonding technologies. Viscose fibres are often blended with others.
Colouration	Treat to remove sulphur and use cellulose dyes

Colouration	Although viscose fibres are usually prepared white they are likely to contain a significant concentration of residual sulphur based chemicals from their processing. It is therefore essential that a suitable bleaching/scouring is carried out prior to any dyeing process. Dyeing can be carried out with reactive dyes or in some cases direct dyes. It is also possible to get pigment dyed fibres that have been spun from coloured dope. If garments must be suitable for the heavier duty applications in work wear then reactive dyes, vat dyes or sulphur dyes would be recommended.
Dimensional Stability	Susceptible to shrinking
Dimensional Stability	Viscose fibres looses 30% to 50% of its strength when wet and this can cause some problems. 10% shrinkage can be expected
Resistance to pilling	Resistant to pilling
Resistance to pilling	Resistant to pilling
Moisture regain	Moderate regain up to 15%
Moisture regain	Being cellulose based, viscose will absorb high levels of moisture dependent upon the ambient conditions. Typically at 65% RH levels of between 12%-15% are typical.
Care information	Dry-cleaning recommended for 100% viscose
Care information	Viscose has poor strength when wet and therefore many viscose garments should only be dry-cleaned. There are however some fabrics that are suitable for machine or hand washing. These garments should be washed using lukewarm or cool cycles avoiding any wringing or twisting of the garments in order to prevent damage. Air-drying is recommended, laying heavier garments such as sweaters flat to prevent distortion. Ironing while slightly damp is recommended using a moderate heat setting. It is recommended that ironing is carried out on the reverse side of the fabric or under a suitable pressing cloth.

Applications	
Applications	Viscose woven fabrics are used for suit linings. Viscose fibres are frequently used
End of life Possibilities.	Can be disposed of using all end of life opportunities
End of life Possibilities.	Viscose is 100% cellulose and as such it is biodegradable. The fibre has also the potential for re-use and remanufacture. Where used as 100% viscose there is the possibility of using the fabrics as a raw material for regenerated cellulose fibre production. When present in blends, the end of life options may be reduced. Ideally viscose should not be sent to landfill. The re-use of the non-woven viscose fabrics will depend on the way they have been manufactured.
Cost scope (economic impact)	
Common trade names	Lenzing Viscose,
Alternatives	
Specialists	Lenzing Fibers Limited 1 Pride Point Drive Pride Park Derby Derbyshire UK DE24 8BX Phone: +44 (0)1332 546 740 Fax: +44 (0)1332 546 741 E-mail: j.blenkinsop@lenzing.com

13.4 Acrylics data sheet.

13.4.1 Property summary for acrylics

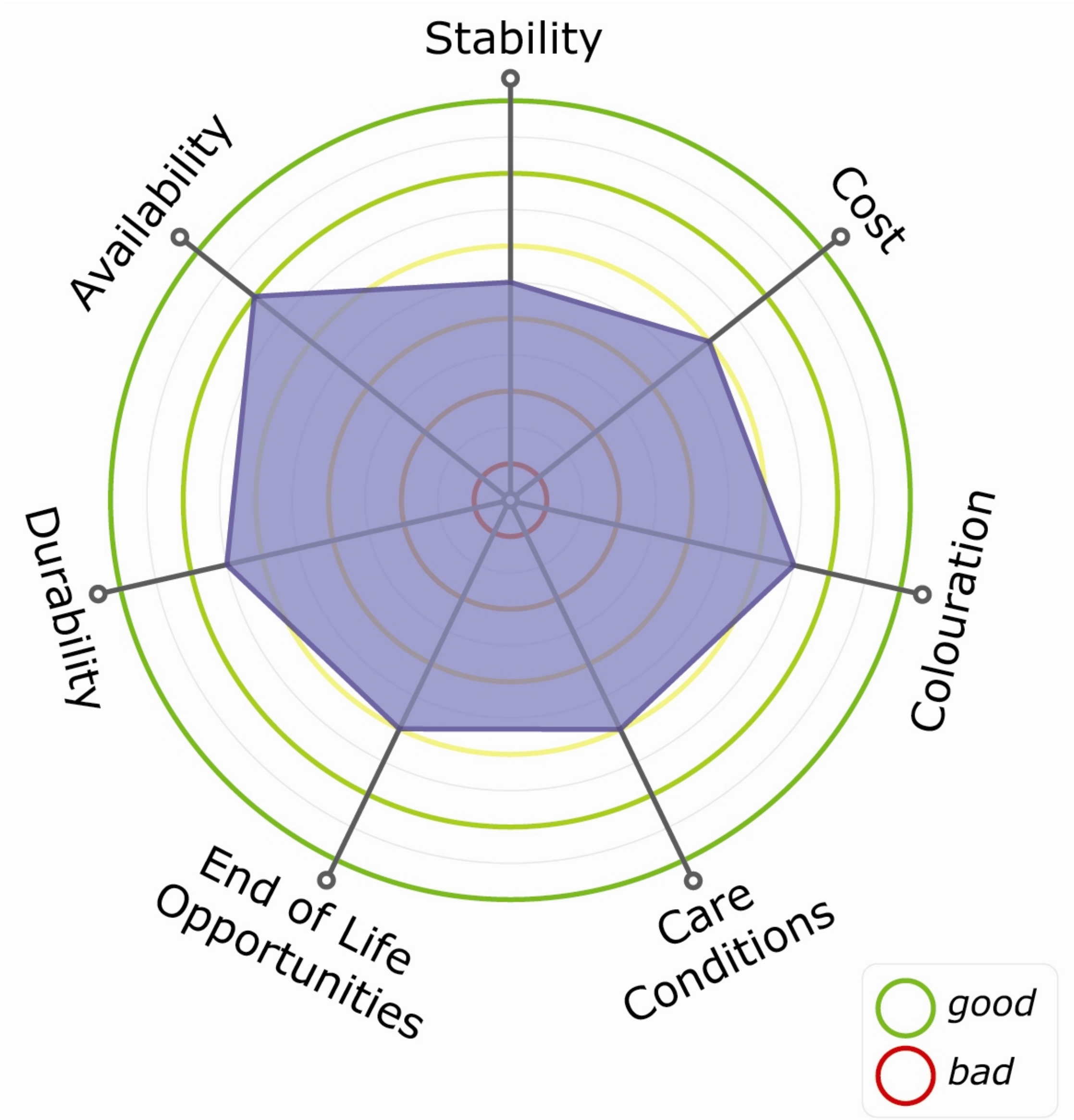

Figure 30 Property summary for acrylics.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.4.2 End of life Opportunity summary for acrylics

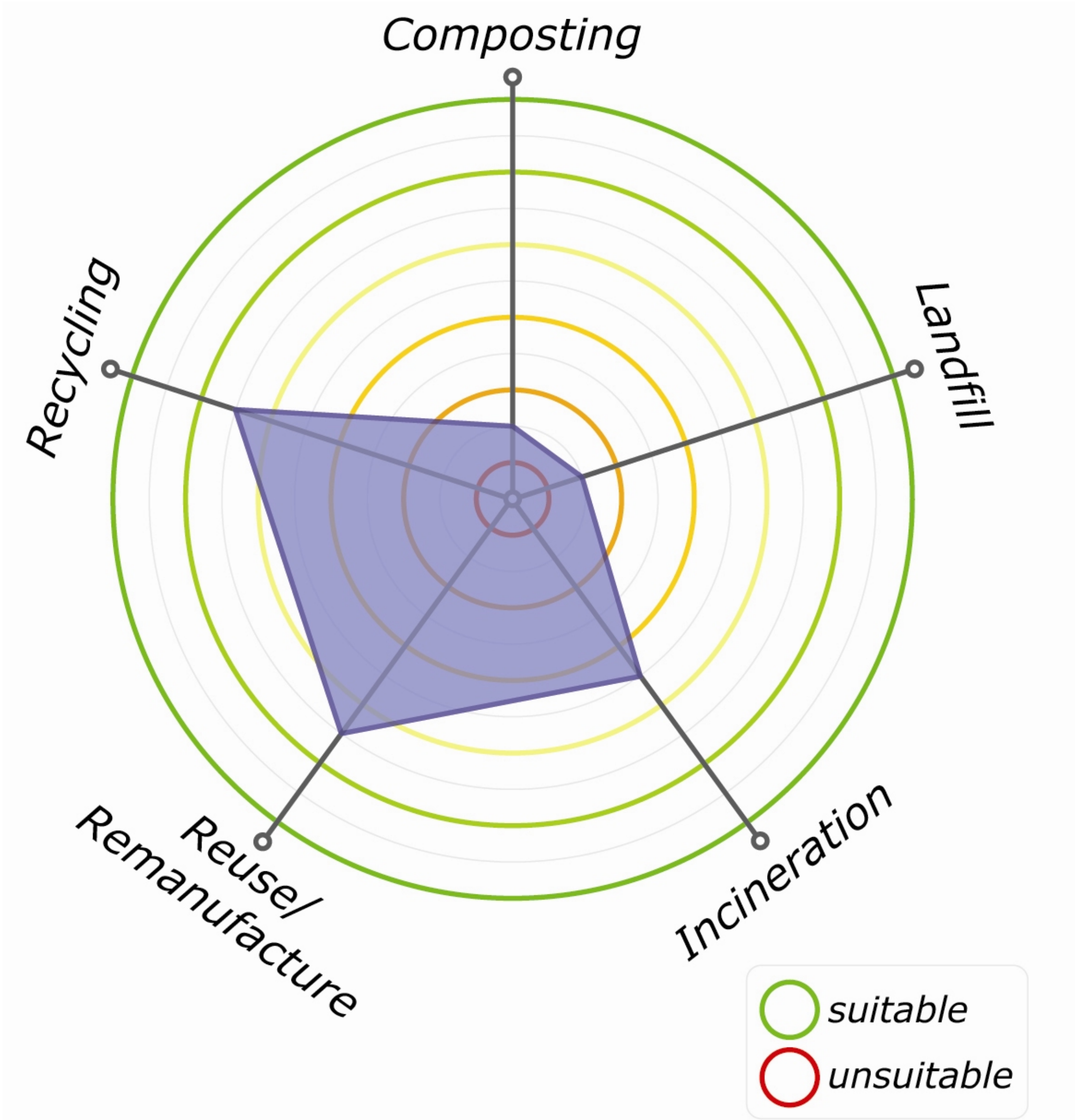

Figure 31 End of life opportunities for acrylics.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.4.3 Data sheet for acrylics

	Acrylics
General	Synthetic fibre from oil.
General	A synthetic fibre that possess wool-like properties. Currently 75% of acrylic fibre production is used in clothing manufacture, seeing applications in range of products where it is suitable for use in knitwear. Acrylic fibres can be manufactured to have high bulk and are then ideal for use where good thermal insulation is a pre-requisite. Modacrylics are acrylic fibres that are manufactured with inherent fire retardant properties and are ideal where these are required.

Available as:	Wide range of woven and knitted fabrics
Available as:	Generally the fibre used in garments will be as staple. Though predominantly available as 100% fibre, it can be blended with other fibres such as wool. The majority of application of acrylic fibres in corporate clothing will be as knitwear.
Colouration	white through to black possible
Colouration	Bleaching acrylic fibres is best carried out using a chlorine dioxide based bleach. Acrylics fibres can be dyed using disperse and basic dyes. Pigment dyed fibres are also available where the pigments are added to the spinning dope prior to fibre extrusion. These will have a uniform colour throughout the fibre cross section. It can be dyed to bright colours with excellent colour fastness.
Dimensional Stability	Generally good
Dimensional Stability	Fabrics produced from acrylic fibres are generally considered to have good dimensional stability, however this will be influenced by the nature of the fabric construction. Loose knits may suffer if hang to dry.
Resistance to pilling	poor resistance
Resistance to pilling	Acrylic fabrics are often susceptible to pilling and do suffer from poor abrasion resistance.

Moisture regain	rapid regain and loss possible
Moisture regain	Acrylic fibres show a low level of moisture regain, approximately 2%
Care information	warm wash or dry-clean
Care information	Acrylic garments may be washed or dry-cleaned. Machine washing with a warm water cycle is recommended with the use of a fabric conditioner to reduce static. Acrylic garments can be tumble-dried but this should be carried out at a low temperature setting with the garments being removed as soon as they are dry. Knitted acrylics should be dried flat to prevent the garments becoming misshapen. Drying over radiators is not recommended. When there is a need to iron the garments a moderate heat setting should be used.
Applications	95% of production into knitwear
Applications	Apparel - sweaters, socks, fleece, circular knit apparel, leisurewear,
End of life Possibilities.	Not biodegradable & may generate noxious fumes on burning
End of life Possibilities.	Garments made from acrylic fibres can be re-used. The fibres are resistant to biodegradation and therefore disposal to any process reliant on this, is not viable and landfill would be needed. Incineration is a possibility however conditions must be such as to prevent the formation of toxic by-products such as cyanide, from the fibres.
Cost scope (economic impact)	
Common trade names	Dolan, Dralon, Courtelle, Leacryl, Orlon
Alternatives	generally used as an alternative to wool

13.5 Polyester data sheet.

13.5.1 Property summary for polyester

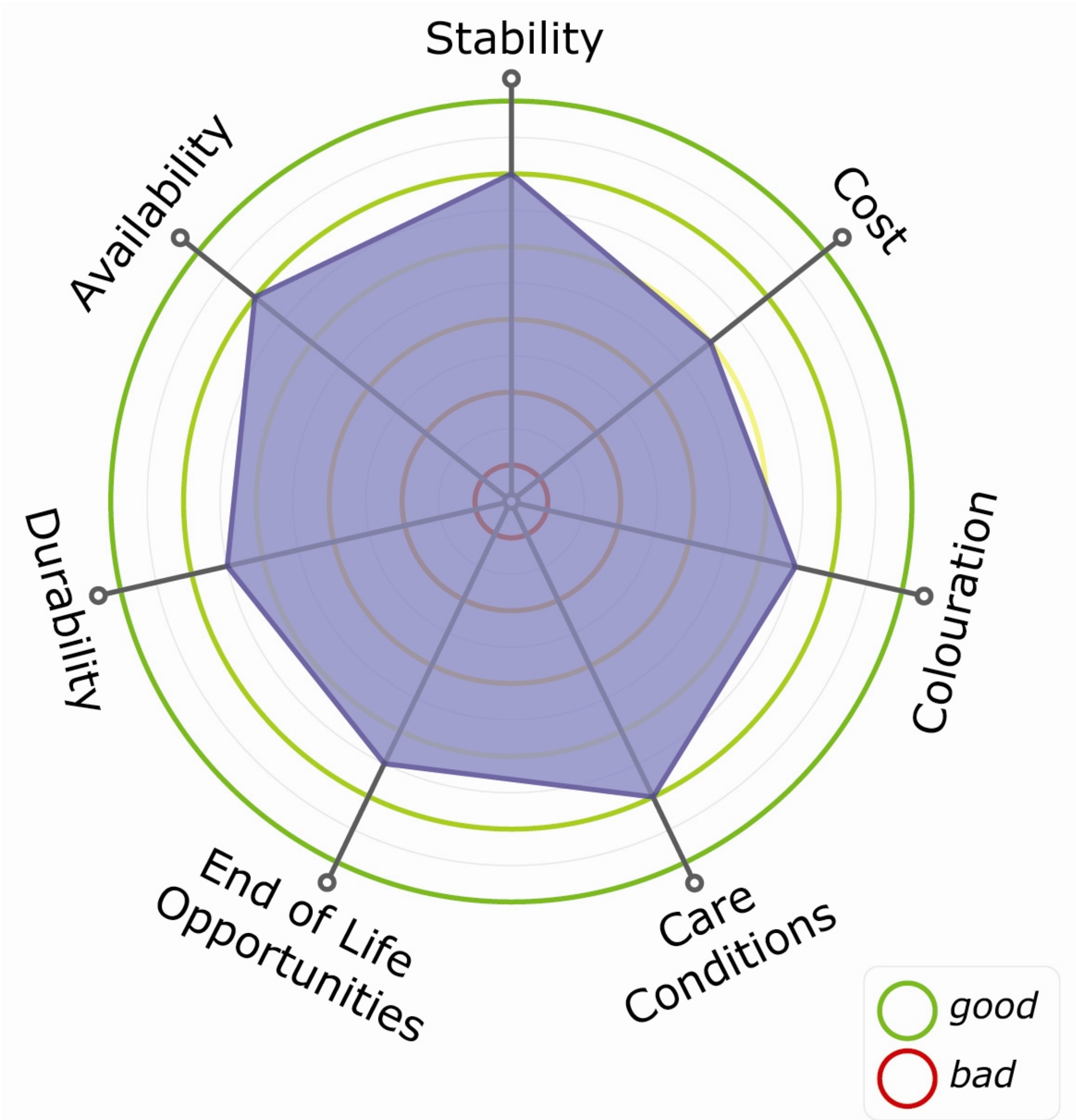

Figure 32 Property summary for polyester.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.5.2 End of life Opportunity summary for polyester

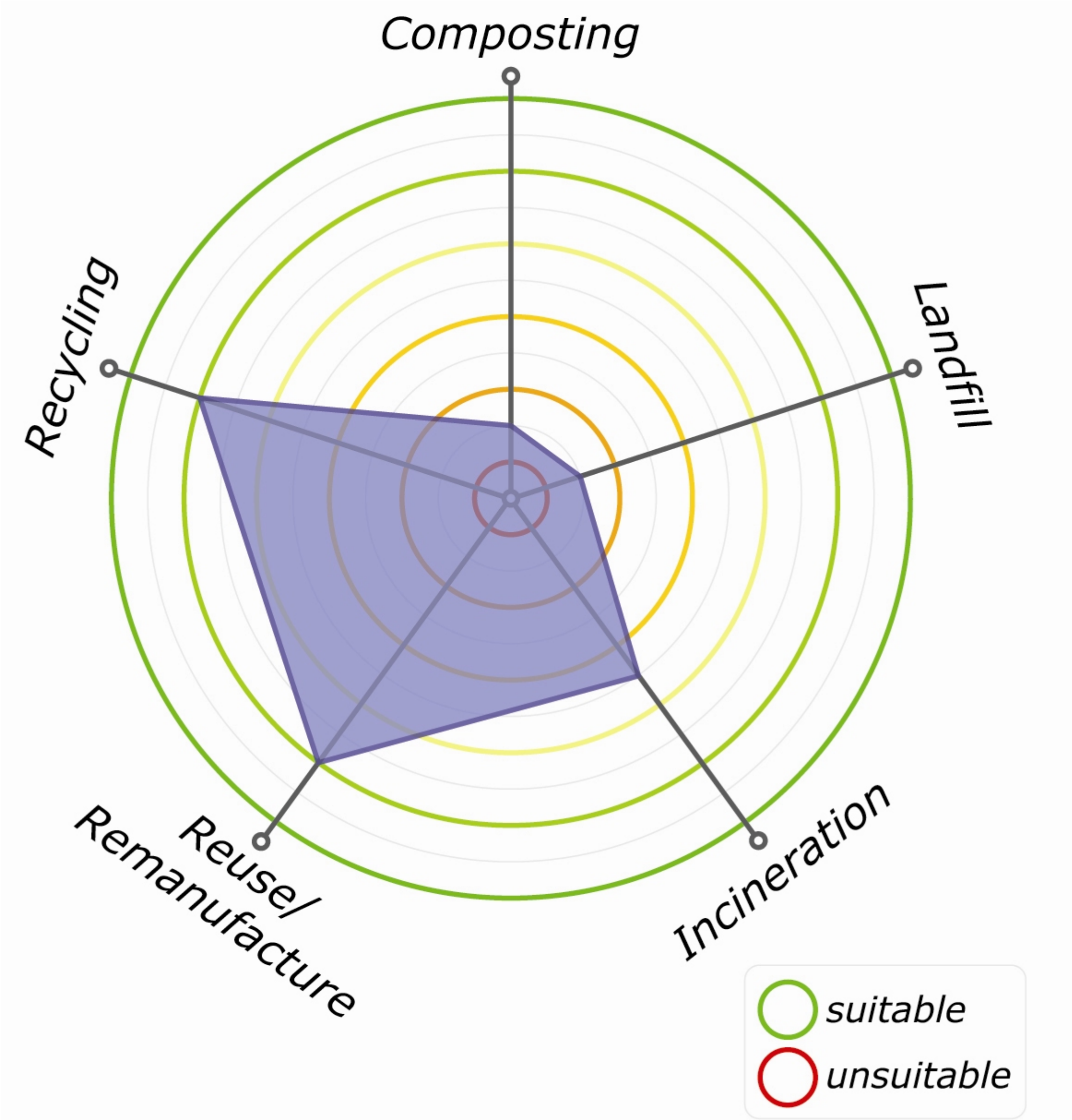

Figure 33 End of life opportunities for polyester.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.5.3 Data sheet for polyester

	Polyester
General	An oil based synthetic fibre.
General	An oil based synthetic fibre, Polyester is the most used of all the man made fibres. Polyester is the best wash-and-wear fibre. In addition, when polyester is blended with other dry-clean only fibres, like wool, acetate, or rayon, the durability of the blended fabric improves and, in some cases, the fabrics can even be made washable, if the percentage of polyester is high enough. A fibre that is capable of re-processing, fibres manufactured from recycled polyester are now available on the market. Polyester fabrics tend to be resistant to creasing and are resistant to UV radiation. Specialist polyester fibres can be supplied where the use of multilobed cross sections or fire retardant properties are required for specific end uses. Recycled polyester is now available and will possess the same properties as conventional polyester.
Available as:	Wide range of fabrics available
Available as:	Polyester fibre is available as continuous filament and staple fibre. As a staple product it is often blended with other fibres to provide yarns with properties designed fro specific end uses. As a continuous filament yarn the fibre is woven, producing fabrics often used in suit linings. Fabrics produced from blended yarns will come in a range of blend compositions and fabric weights. The end use will often determine both the composition and fabric weight
Colouration	wide range of colours available
Colouration	Polyester fibres do not usually require bleaching and are often treated with an optical brightener that improves whiteness. Dyeing polyester fibres is usually carried out with disperse dyes. Good colour fastness to washing and light.
Dimensional Stability	shrink resistant
Dimensional Stability	Polyester fabrics are resistant to shrinking but can have natural stretch.
Resistance to pilling	resistant to pilling

Resistance to pilling	Fabrics produce from polyester have good abrasion resistance and are resistant to pilling.
Moisture regain	Very low
Moisture regain	Low moisture absorption, typically 2-4% at 65% RH
Care information	Machine wash or dry-clean
Care information	Most items made from polyester are suitable for either machine washing or dry-cleaning. A warm water cycle can be used with the addition of a fabric conditioner during the rinse cycle to minimise potential static build-up. Tumble drying at a low temperature and removal as soon as the garments are dry should overcome a need for ironing. If it is necessary to iron polyester garments then a moderately warm iron should be used.
Applications	Widespread use is apparel
Applications	Polyester clothing has a good stability and strength and is resistant to stretching and shrinkage. It is not damaged by sunlight or weather. It is widely used as dresses, blouses, jackets, separates, leisurewear, suits, shirts, rainwear,
End of life Possibilities.	Non biodegradable by suitable for all others
End of life Possibilities.	In general polyester is not bio-degradable and is therefore unsuitable for composting. Disposal to landfill is regarded as an option, however as a melt spun fibre it is possible to re-manufacture the polyester into more fibre or film for other applications. Fibres produced from re-processed polyester are available.
Eco aspects	**Key environmental impacts of producing polyester include:**
	• The consumption of non-renewable resources (petrochemicals) in fibre production
	• Relatively large energy consumption in production, which has far-reaching environmental implications, the most serious of which includes global warming

	• **Emissions to air and water that have a medium to high potential of causing environmental damage if discharged untreated including: heavy metal cobalt; manganese salts; sodium bromide and titanium dioxide**
	• **The cost of disposal – synthetic fabrics like polyester are extremely slow to biodegrade and add to the environmental impact of landfill sites in the very long term.**
Cost scope (economic impact)	
Common trade names	Trevira, Diolen, Dacron, Coolmax Patagonia (recycled polyester)
Alternatives	
Specialists	Carrington Career & Workwear Ltd, Market Street Adlington Nr Chorley Lancashire PR7 4HJ Tel: +44 (0) 1257 476 850 Fax: +44 (0) 1257 476 863 Email: info@carrington-cww.co.uk

13.6 *Nylon data sheet.*

13.6.1 Property summary for nylon

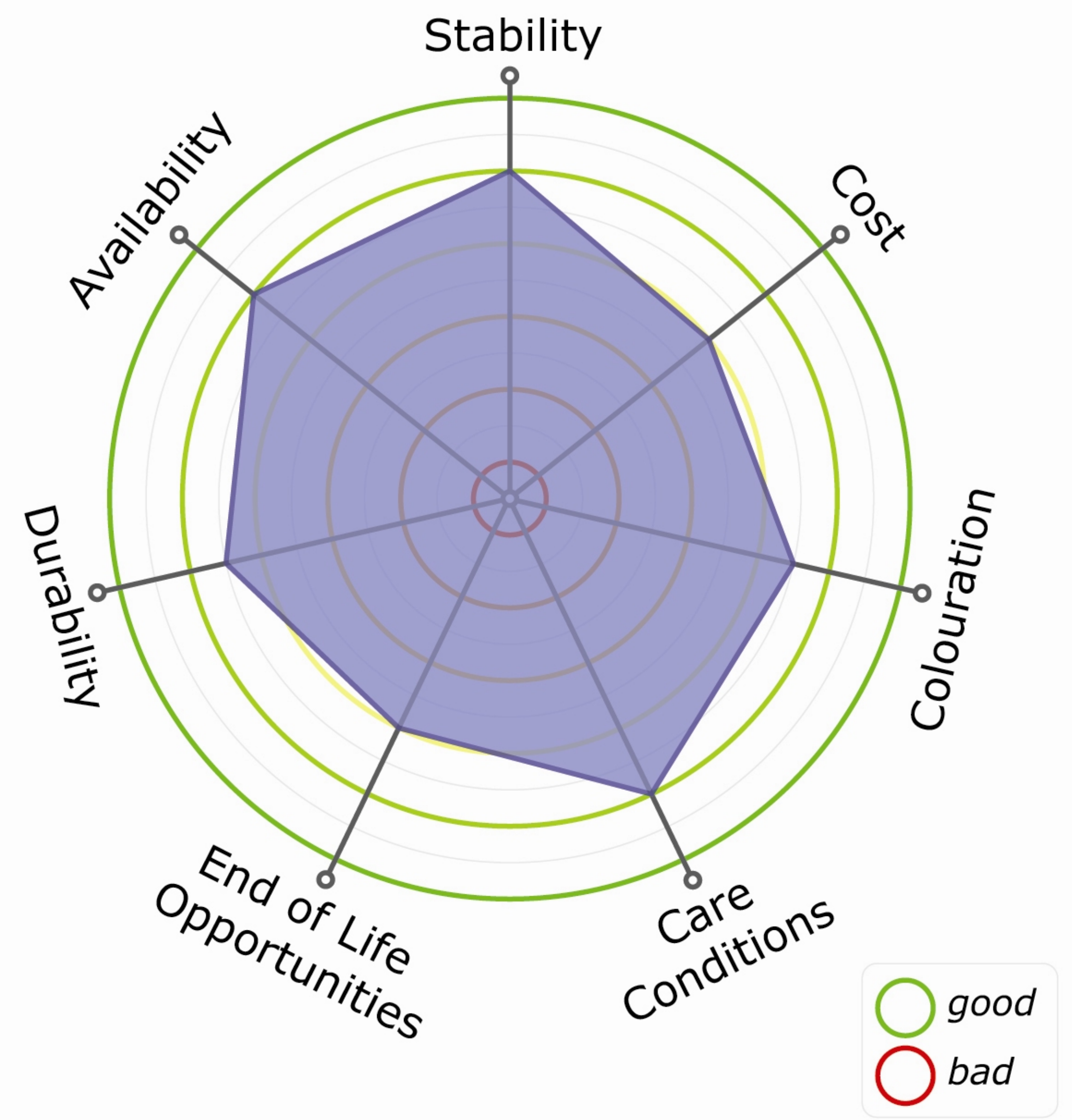

Figure 34 Property summary for nylon.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.6.2 End of life Opportunity summary for nylon.

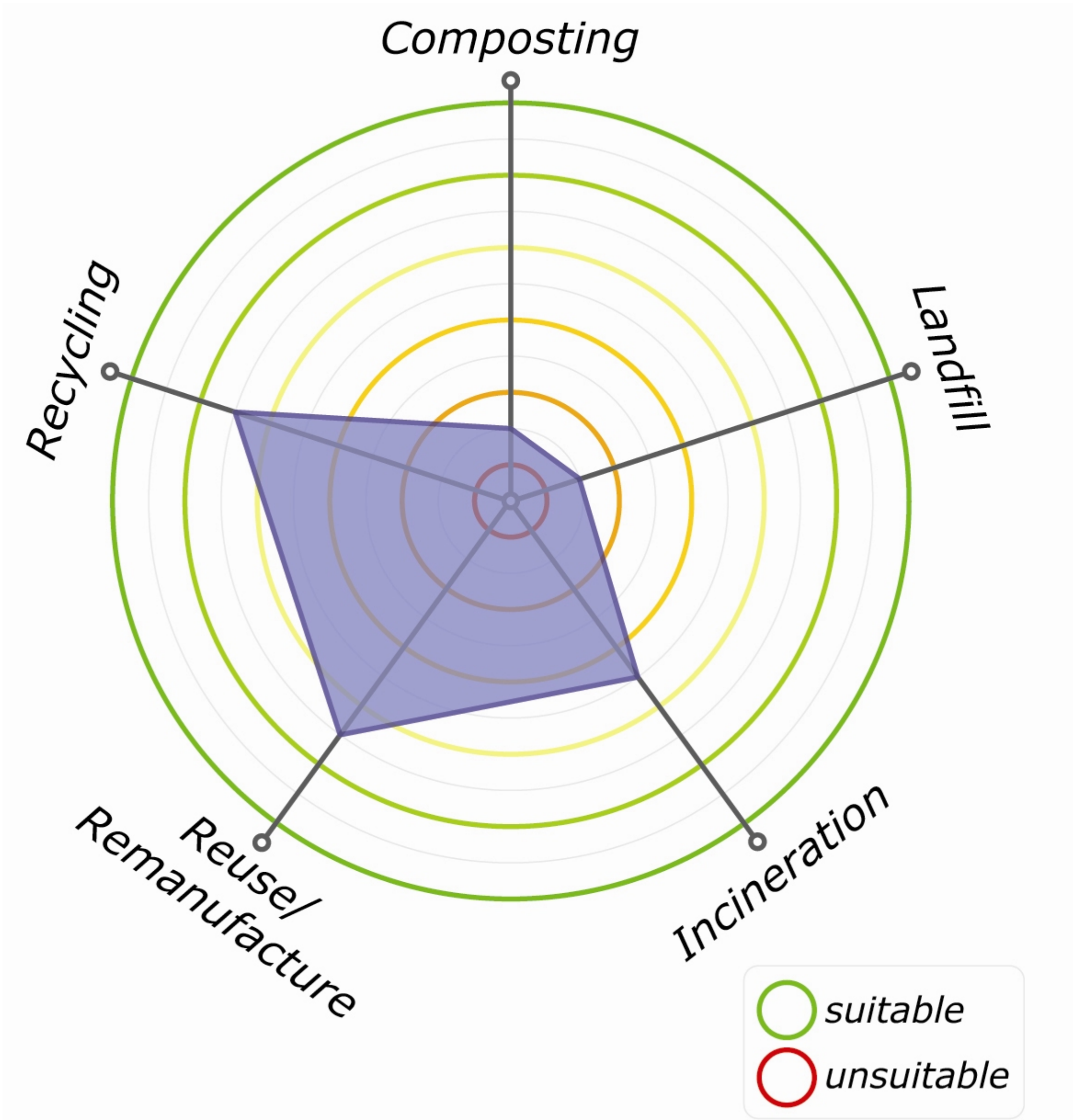

Figure 35 End of life opportunities for nylon.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.6.3 Data sheet for nylon.

	nylon
General	Oil based synthetic fibre
General	An oil based synthetic fibre, nylon is probably the most durable of the synthetic fibres used in corporate clothing. It is not used as widely as polyester for several reasons, among which are that it is more prone to staining, it has poorer UV resistance and more prone to creasing during industrial laundering. It is however used in garments such as fleeces and outerwear where the superior abrasion resistance is of benefit.
Available as:	Knitted and woven fabrics with range of weights
Available as:	nylon fibre is available as continuous filament and staple fibre. It can be found blended with other fibres though is more often used as a homogeneous fibre. Nylon is available as knitted and woven fabrics.
Colouration	Easy to dye
Colouration	Nylon fibres do not usually require bleaching and can be dyed more easily than polyester.
Dimensional Stability	Nylon fabric are shrink resistant
Dimensional Stability	nylon fabrics are resistant to shrinking but can have natural stretch.
Resistance to pilling	resistant to pilling, excellent abrasion resistance
Resistance to pilling	Fabrics produce from nylon have very good abrasion resistance and are resistant to pilling.
Moisture regain	Very low
Moisture regain	Low moisture absorption, typically 2-4% at 65% RH
Care information	Warm wash,

Care information	Most items made from nylon are suitable for either machine washing or dry-cleaning. A warm water cycle can be used with the addition of a fabric conditioner during the rinse cycle to minimise potential static build-up. Tumble drying at a low temperature and removal as soon as the garments are dry should overcome a need for ironing. If it is necessary to iron nylon garments then a moderately warm iron should be used. Industrial laundering can lead to crease formation
Applications	Mainly in outerwear
Applications	Nylon clothing has a good stability and strength and is resistant to stretching and shrinkage. There is a tendency for UV degradation but the fibre still finds widespread use in outerwear.
End of life Possibilities.	Non biodegradable and therefore some limitations
End of life Possibilities.	In general nylon is not bio-degradable and is therefore unsuitable for composting. Disposal to landfill is regarded as an option, however as a melt spun fibre it is possible to re-manufacture the nylon into more fibre or other applications. Fibres produced from re-processed nylon are available. This process is not however as easy as with polyester. Coated fabrics will have very limited opportunities at the end of life.
Cost scope (economic impact)	
Common trade names	Patagonia (recycled nylon)
Alternatives	
Specialists	Du Pont (U.K.) Limited Wedgwood Way Stevenage Herts SG1 4QN Tel: + 0044 (0) 1438 73 4000 Fax : + 0044 (0) 1438 73 4836

13.7 *Lyocell data sheet.*

13.7.1 Property summary for lyocell

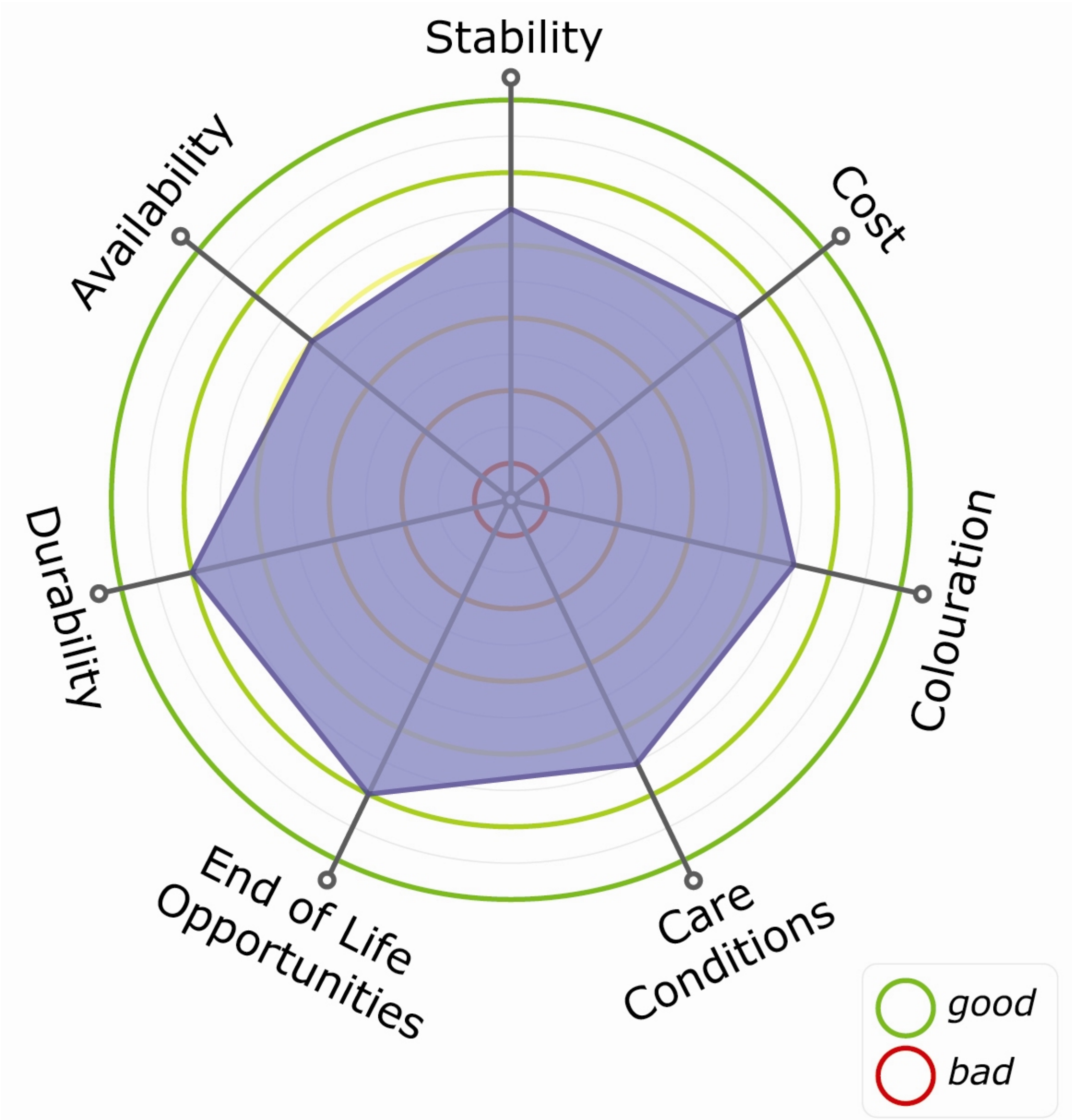

Figure 36 Property summary for lyocell.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.7.2 End of life Opportunity summary for lyocell.

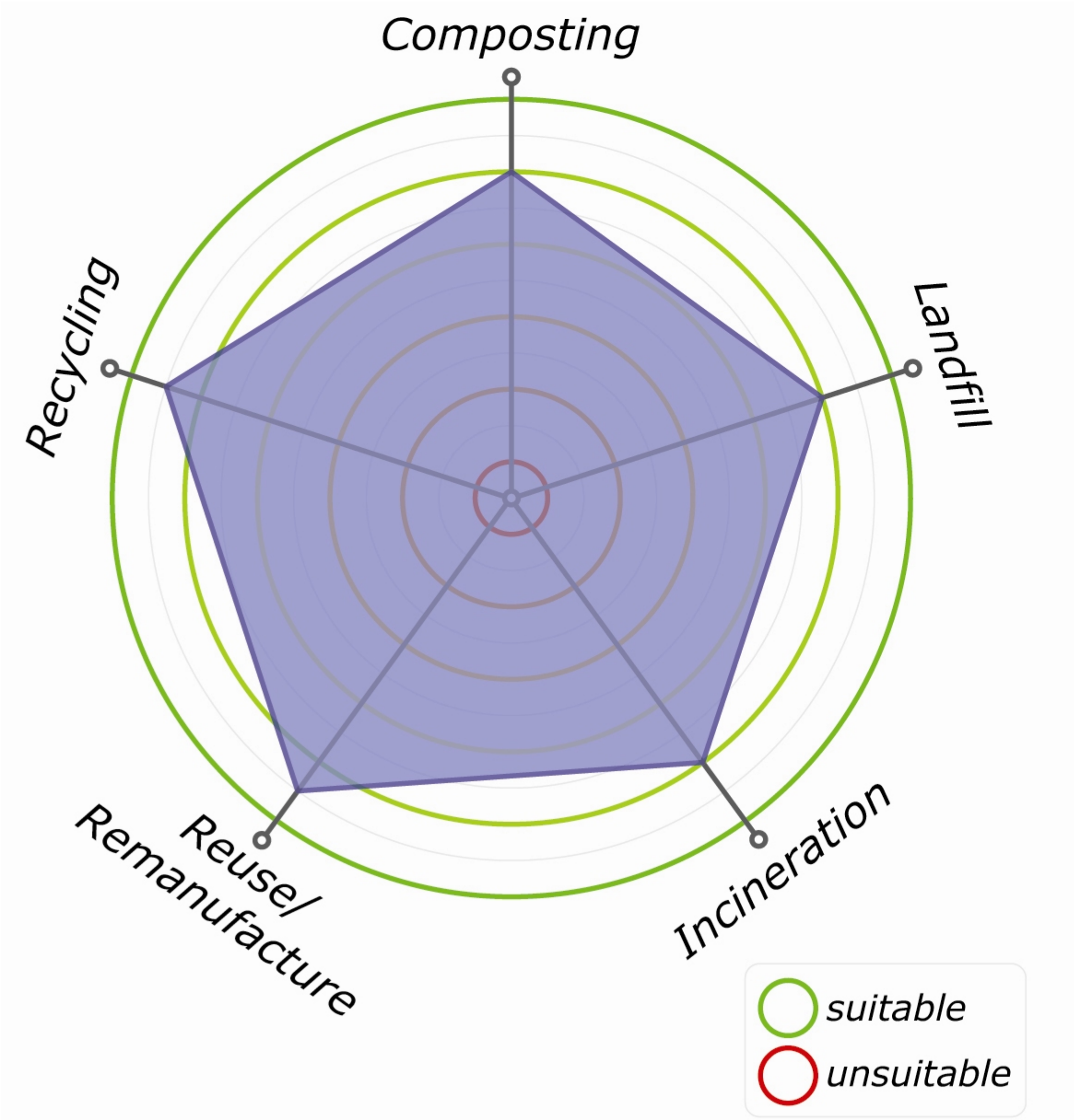

Figure 37 End of life opportunities for lyocell.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.7.3 Data sheet for lyocell.

	Lyocell
General	Regenerated Cellulose fibre
General	Lyocell fibres are produced through an environmentally friendly solvent process. There is very little solvent loss during the process and the water consumption is a fraction of that associated with the production of cotton. Lyocell fibres are strong with a circular cross section and a smooth surface. While some variants have a tendency to fibrillate, this property is used to good advantage in the development of specialised surface effects. Fibrillation resistant variants are also available using similar technologies to those used in the treatment of easy care cotton.
Available as:	100% and blended yarns
Available as:	Lyocell fibres can be obtained as 100% yarns or blended. In addition to woven fabrics, lyocell is supplied as non-woven fabrics suitable for inter-linings. Woven fabrics manufactured from blended yarns with cotton or polyester may contain typically 50-65% lyocell. These would be in the range 130-250gsm. Knitted double pique fabrics 230gsm are also available.
Colouration	Easy to dye using cellulose dyes
Colouration	Lyocell does not suffer from the presence of residual sulphur compounds in the way that other regenerated cellulose fibres do and therefore the need for specialised bleaching prior to dyeing is less critical. Cross linked lyocell (the low fibrillating variant) is ideally treated with hydrogen peroxide with peracetic acid. Dyeing can be carried out in the same way as other cellulose fibres such as cotton. High temperature processing can be undertaken.
Dimensional Stability	Good stability.

Dimensional Stability	The dimensional stability of lyocell fabrics is good and when blended with other fibres can help to stabilise their dimensional stability. When wet the fibres will swell significantly, however original dimensions will be regained when the fibres dry.
Resistance to pilling	Can be susceptible to pilling
Resistance to pilling	Wet abrasion of lyocell fibres can result in fibrillation and pilling can form around the fibrillated materials. Modified version of lyocell which are more resistant are available. Processes
Moisture regain	Very high regain
Moisture regain	Lyocell fibres have the ability to absorb up to 25% moisture at 65% RH, approximately three times that of cotton and twice that of wool.
Care information	Low temperature washing is preferred
Care information	It is important to follow fabric suppliers recommendations when it comes to the laundering of lyocell. Garments (fabric) may be suitable for either machine washing or dry-cleaning. Machine washable lyocell can be washed at low temperature and tumble dried. It should be removed from the drier as soon as it is dry. If ironing is required, use a moderately warm iron. Lyocell has been shown to be as durable as cotton under industrial laundering conditions up to 75C.
Applications	Mostly as woven fabrics
Applications	Currently lyocell fibres are not widely used in corporate clothing. As a cellulose based fibre it is able to provide many of the attributes associated with cotton and is a strong fibre. Ideally suited for woven fabrics used in shirting fabrics, lyocell is also available in non-woven fabrics that would find applications in interfacings in suiting. Applications in leisure wear (polo shirts), knitwear and shirts
End of life Possibilities.	Can be disposed of using all end of life opportunities

End of life Possibilities.	Lyocell is 100% cellulose and as such it is biodegradable. The fibre has also the potential for re-use and remanufacture. Where used as 100% lyocell there is the possibility of using the fabrics as a raw material for regenerated cellulose fibre production. When present in blends, the end of life options are reduced. The re-use of the non-woven lyocell fabrics will depend on the way they have been manufactured. Low fibrillation variants of lyocell may be resistant to the regeneration processes and therefore may not be suitable feedstock for these processes. These low fibrillation fibres are also considered to be more resistant to biodegradation. Composting, incineration and landfill can all be used as end of life options.
Eco aspects	Considered to be an environmentally friendly fibre. It is produced from a solvent spinning process that recovers the majority(99.6%) of the solvent used and the process uses very little water, most being recycled within the process.
Cost scope (economic impact)	Currently being developed commercially for the corporatewear market and data are not available.
Common trade names	Tencel,
Alternatives	seen as an alternative to existing fibres.
Specialists	Lenzing Fibers Limited 1 Pride Point Drive Pride Park Derby Derbyshire UK DE24 8BX Phone: +44 (0)1332 546 740 Fax: +44 (0)1332 546 741 E-mail: j.blenkinsop@lenzing.com

13.8 *Modal data sheet.*

13.8.1 Property summary for Modal.

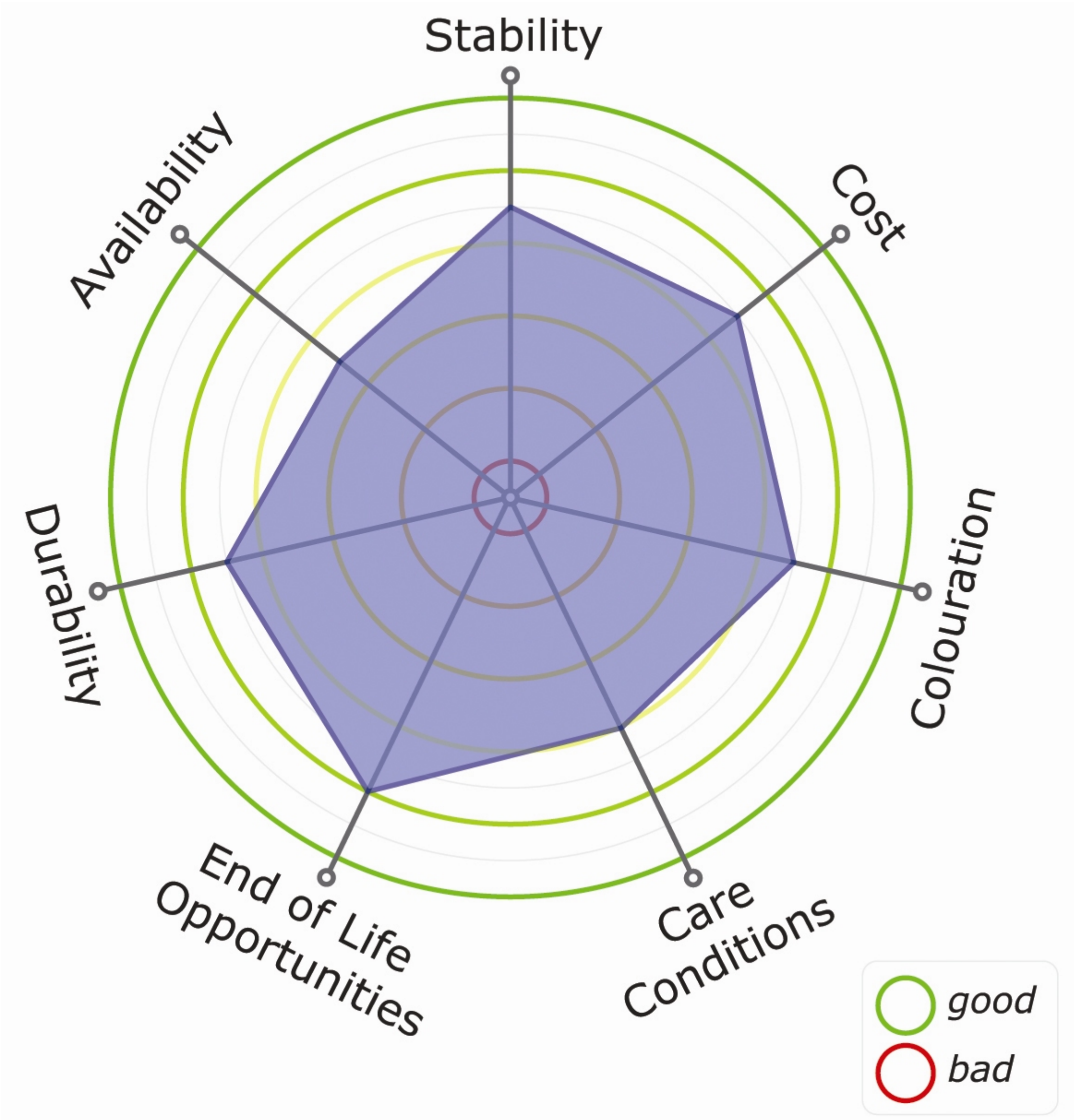

Figure 38 Property summary for modal.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.8.2 End of life Opportunity summary for Modal.

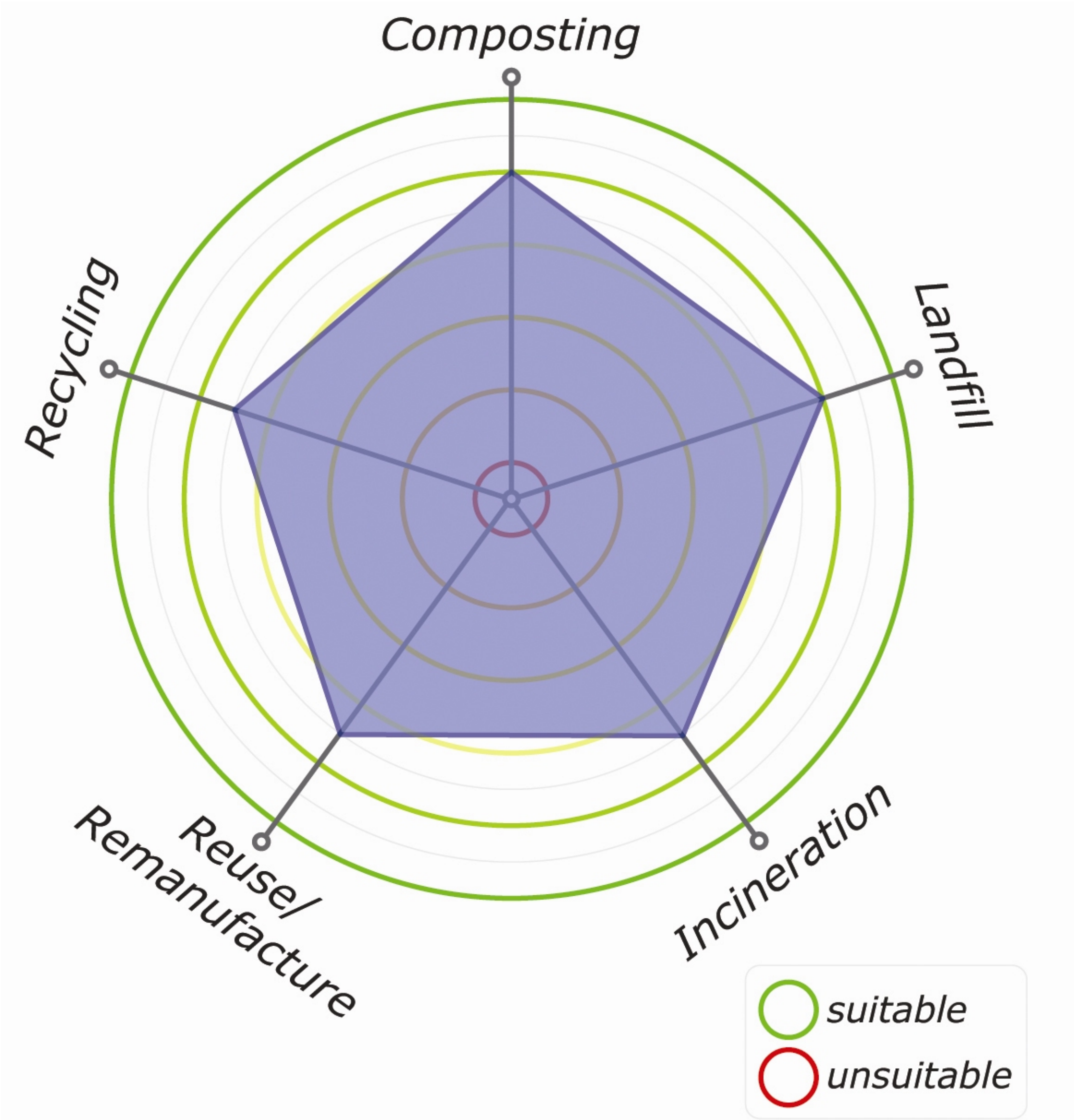

Figure 39 End of life opportunities for modal.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.8.3 Data sheet for Modal.

	Modal
General	Regenerated Cellulose fibre
General	Modal fibres are a form of viscose fibres and manufactured through a complex chemical process. Converted into a series of intermediate cellulose compounds, the final spinning process regenerates cellulose from a cellulose xanthate dope. Involving strong sodium hydroxide and sulphuric acids as well as carbon disulphide, there are environmentally concerns surrounding the process. Modal fibres have improved wet strength over standard viscose fibres and is abrasion resistant yet soft to handle and has good drape properties. It is extremely adsorbent and breathable which combine to make garments made from the fibre comfortable
Available as:	knitted and woven in 100% and blended
Available as:	Modal is supplied as 100% or more frequently in blends. In this latter application it is used to improve the underlying properties of the other fibres. Modal yarns can be knitted or woven and come in a range of yarn/fabric weights.
Colouration	Treat to remove sulphur and use cellulose dyes
Colouration	Modal fibres will have similar requirements to viscose as they will contain a significant concentration of residual sulphur based chemicals from their processing. It is therefore essential that a suitable bleaching/scouring is carried out prior to any dyeing process. Dyeing modal fibres is totally compatible with cotton systems and as such can be carried out with reactive dyes or in some cases direct dyes. It is also possible to get pigment dyed fibres that have been spun from coloured dope. If garments must be suitable for the heavier duty applications in work wear then reactive dyes, vat dyes or sulphur dyes would be recommended.
Dimensional Stability	Excellent dimensional stability
Dimensional Stability	Excellent dimensional stability

Resistance to pilling	resistant to pilling
Resistance to pilling	The abrasion resistance and pilling resistance of Modal is good
Moisture regain	better than cotton 12-15%
Moisture regain	Modal has a high level of moisture regain, typically 12-15% at 65% RH 20C
Care information	cool wash
Care information	Easy care, suitable for cool washing
Applications	knitwear, leisurewear
Applications	ladies' knitwear, leisurewear
End of life Possibilities.	Can be disposed of using all end of life opportunities
End of life Possibilities.	Modal is a variant of viscose fibre, being produced using the same process but under modified conditions. It can be treated as viscose fibre. It is 100% cellulose and as such it is biodegradable. The fibre has also the potential for re-use and remanufacture. Where used as 100% there is the possibility of using the fabrics as a raw material for regenerated cellulose fibre production. When present in blends, the end of life options are reduced. However if blended with other cellulose fibres then the blend can be treated as cellulose feed stock for a regenerated cellulose process. The re-use of the non-woven viscose fabrics will depend on the way they have been manufactured.
Cost scope (economic impact)	
Common trade names	Lenzing Modal
Alternatives	

Specialists	Lenzing Fibers Limited 1 Pride Point Drive Pride Park Derby Derbyshire UK DE24 8BX Phone: +44 (0)1332 546 740 Fax: +44 (0)1332 546 741 E-mail: j.blenkinsop@lenzing.com

13.9 Bamboo data sheet.

13.9.1 Property summary for Bamboo.

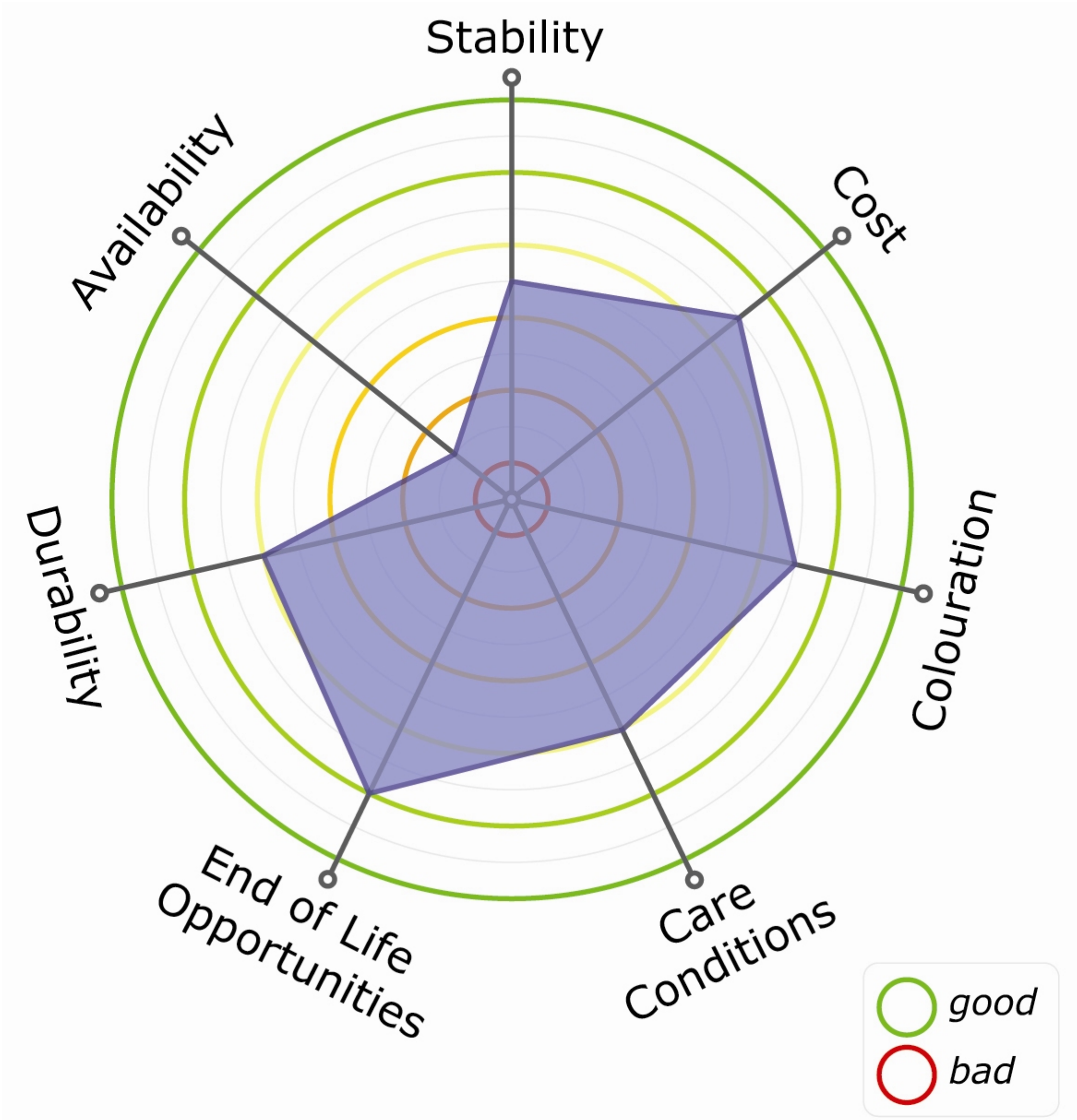

Figure 40 Property summary for bamboo.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.9.2 End of life Opportunity summary for Bamboo.

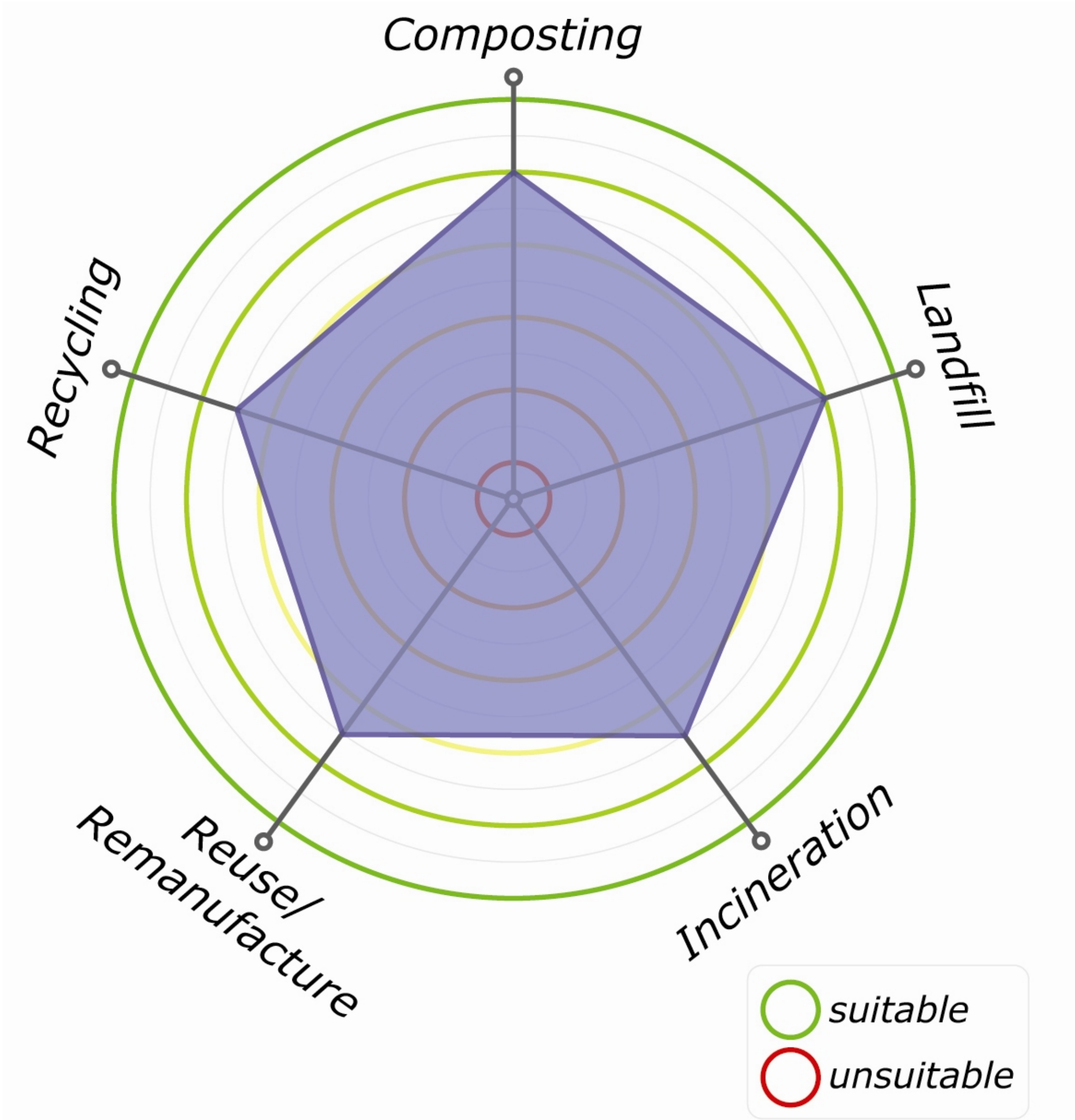

Figure 41 End of life opportunities for bamboo.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.9.3 Data sheet for Bamboo.

	Bamboo
General	Regenerated Cellulose fibre
General	Bamboo fibres are produced using the viscose process from sustainable sources of Moso Bamboo. Environmental concerns relating to the production of standard viscose apply to the production of Bamboo. A major advantaged claimed by bamboo fibres is a natural anti-bacterial property however exposure to strong acids and alkalines during processing would make this unlikely. Distinction between standard viscose fibres and "bamboo" viscose may not be possible. Use of bamboo fibres is on the increase and finding niche markets where the "antimicrobial" properties are seen as a potential advantage.
Available as:	currently limited availability
Available as:	Bamboo fibres are supplied as staple fibre spun into yarns that may be blended with other fibres in the same way as viscose
Colouration	Treat to remove sulphur and use cellulose dyes
Colouration	Since Bamboo fibres are produced using the viscose process, and will encounter the same problems as experienced with viscose. Fibres will often have residual sulphur compounds present after manufacture and will require some form of treatment to reduce these. Fibres can be dyed with reactive dyes or in some cases direct dyes. As with viscose fibre there is the potential to spin pigment dyed fibres. from coloured dope. If the clothes are to be used for work wear reactive dyes, vat dyes or sulphur dyes would be the selection of choice.
Dimensional Stability	Susceptible to shrinking
Dimensional Stability	A reduction of 30% to 50% in the strength of Bamboo fibres can be expected when wet and this may cause some problems
Resistance to pilling	Resistant to pilling
Resistance to pilling	Resistant to pilling

Moisture regain	12-15% regain
Moisture regain	Being cellulose based, bamboo (viscose) will absorb high levels of moisture dependent upon the ambient conditions. Typically at 65% RH levels of between 12%-15% can be expected.
Care information	Dry-cleaning recommended for 100% regenerated bamboo
Care information	Being a "viscose" fibre, bamboo has poor wet strength and this may influence laundering. Currently the fibre is not widely available however similar washing instructions used for viscose fibres should be applied. Dry cleaning is on option for 100% bamboo fabrics while blended yarns can be washed. This should be carried out using lukewarm or cool cycles avoiding any wringing or twisting of the garments in order to prevent damage. Air-drying is recommended, with knitted garments laid flat. Ironing while slightly damp is using a moderate heat setting is preferred when necessary taking care to iron on the reverse side of the garments to prevent the fabric from becoming shiny.
Applications	potentially the same as viscose
Applications	Currently not penetrating into the corporate clothing sector. Regenerated bamboo has the same potential as viscose fibres and as such could be used in woven fabrics for suit linings. Viscose fibres are frequently used
End of life Possibilities.	Can be disposed of using all end of life opportunities
End of life Possibilities.	Bamboo fibres are essentially the same as viscose and can be treated in the same way. The fibres are 100% cellulose and as such are biodegradable. The fibre has also the potential for re-use and remanufacture. Where used as 100% viscose there is the possibility of using the fabrics as a raw material for regenerated cellulose fibre production. When present in blends, the end of life options are reduced. Blending with other cellulose fibres such as cotton, provide the options of using the fibre as a cellulose raw material for regenerated cellulose fibres. The re-use of the non-woven viscose fabrics will depend on the way they have been manufactured.
Cost scope (economic impact)	

Common trade names	
Alternatives	

13.10 Flax data sheet.

13.10.1 Property summary for flax.

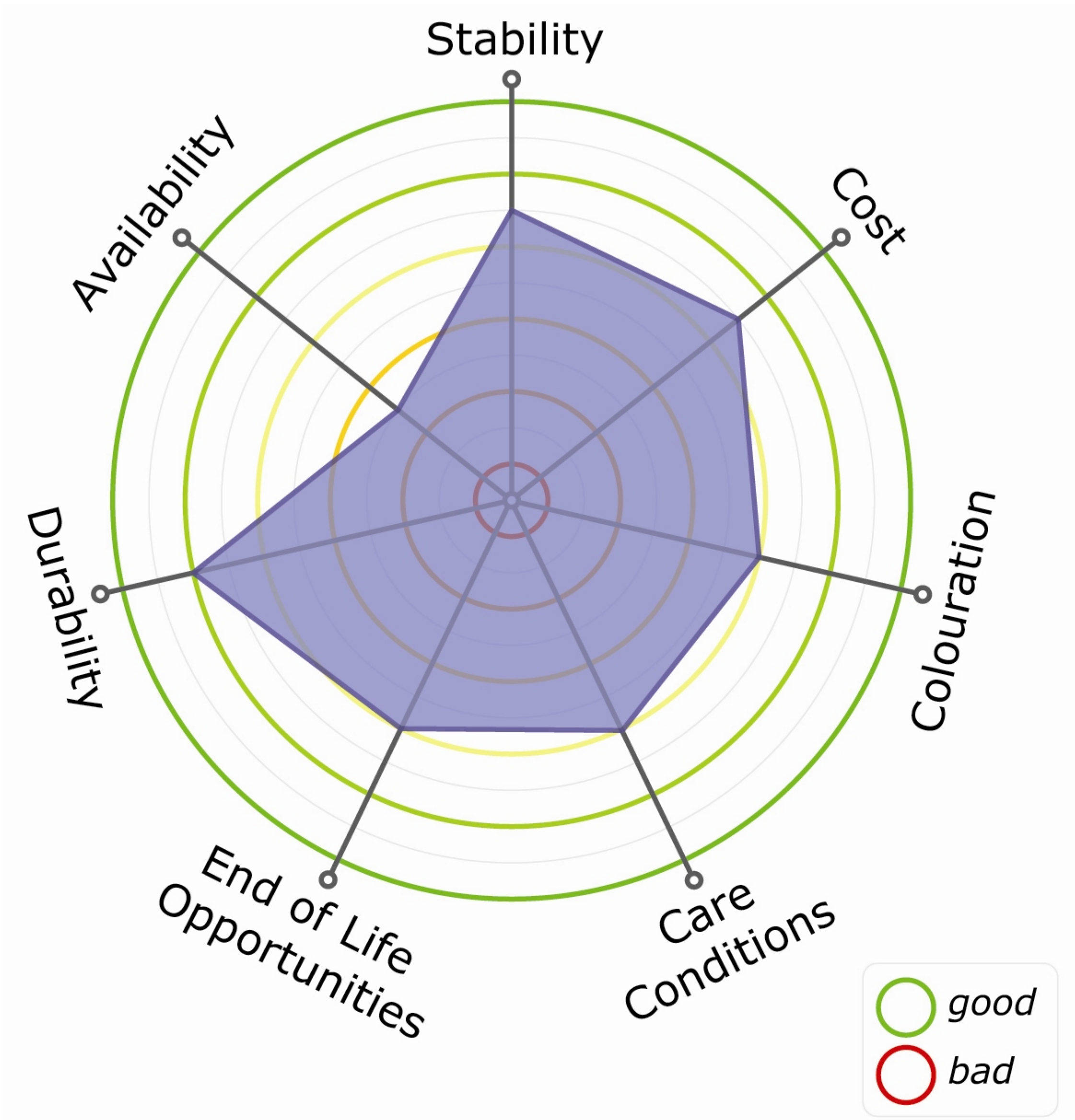

Figure 42 Property summary for flax.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.10.2 End of life Opportunity summary for flax.

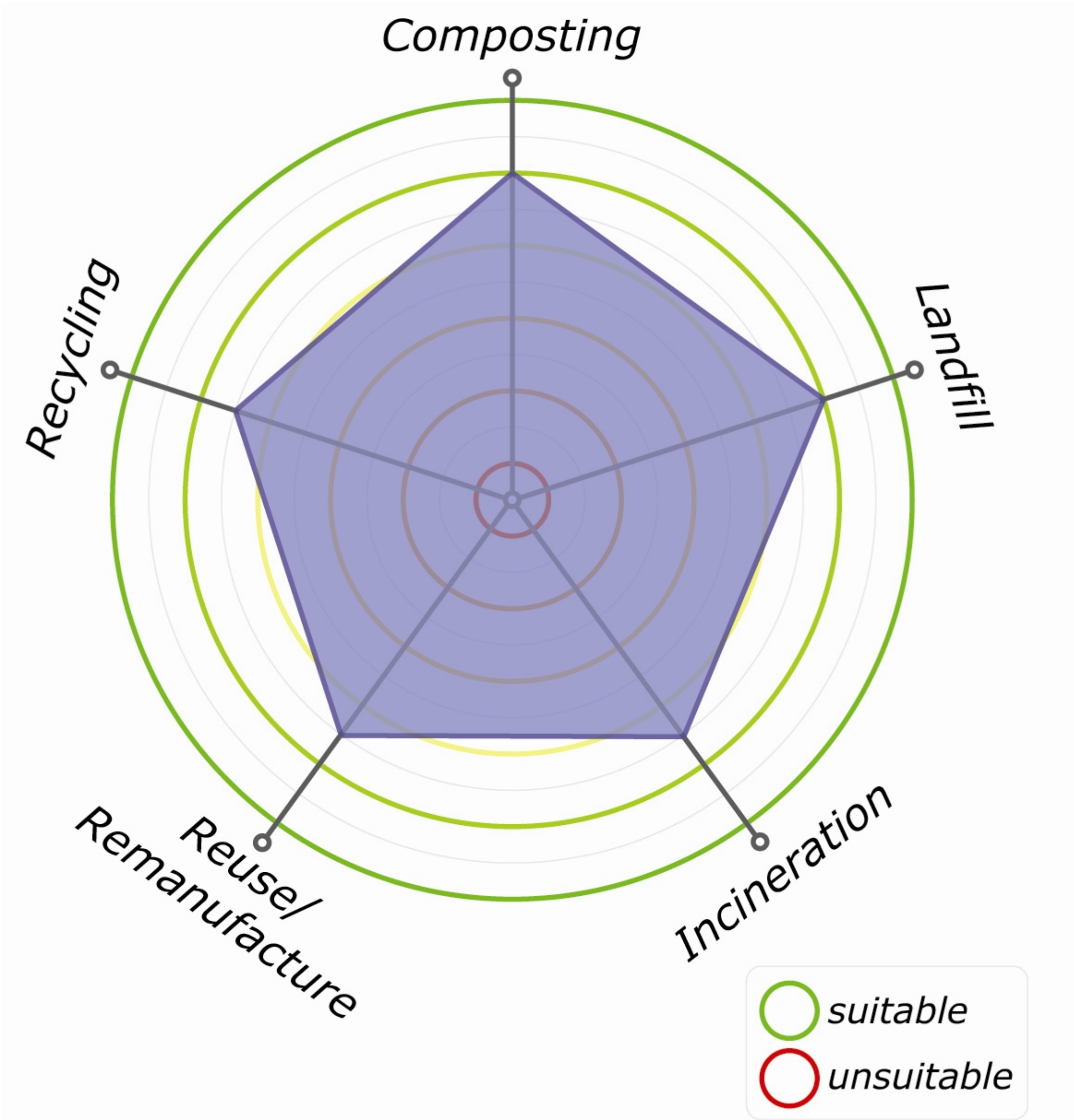

Figure 43 End of life opportunities for flax.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.10.3 Data sheet for flax.

	Flax
General	Natural cellulosic fibre
General	A natural "bast" fibre obtained from flax plants, the fibre is often encountered as linen. Recent developments in agronomy and processing mean that supplies of finer quality fibres are becoming available and finding use in blends with other cellulose fibres, both natural and regenerated.. Flax is a strong durable fibre
Available as:	linen and in some blends
Available as:	100% flax fabrics are generally sold as linen. There has been an increase in the use of flax blends when advantage is taken of the strength of the flax fibres. Currently the fibres find very little application within the corporate clothing field, however woven blends are available in a range of weights.
Colouration	needs bleaching before dyeing, treat as cellulosic
Colouration	Flax naturally has an off-white colour and will therefore require bleaching prior to any dyeing. Hydrogen peroxide bleaching as preparation of the fibre irrespective of the ultimate shade as this preparation route removes most of the extraneous matter in the fibre facilitating better levelling during the dyeing process. The natural colour of flax is often too deep to respond completely to the hydrogen peroxide treatment and a two stage sodium hypochlorite bleach then the hydrogen peroxide bleach is required. This is especially the case when light colours are required. Flax, like other natural cellulosic fibres, can be dyed with reactive dyes or in some cases direct dyes. If the clothes are to be used for work wear where more durable dyes are likely to be required, reactive dyes, vat dyes or sulphur dyes would be the selection of choice.
Dimensional Stability	shrink resistant
Dimensional Stability	Good dimensional stability, fibres tend to have higher strength when wet than dry.
Resistance to pilling	resistant to pilling

Resistance to pilling	Flax fabrics have good resistance to piling
Moisture regain	typically 12%
Moisture regain	Typically 12%
Care information	can be laundered at high temperatures, prone to creasing
Care information	Flax can withstand laundering at high temperatures, these should only be used for heavily soiled garments. Flax fabrics are prone to becoming creased during washing and this will requires the use of a hot (steam) iron during pressing. Dyes have a tendency to bleed and suitable separation during washing should be encouraged. Chlorine based bleaches can be safely used on cotton, although dyed fabric should use a colour safe bleach. Tumble-drying requires a high temperature setting. Like cotton, flax can be treated with a crease resistant finish which can improve the "easy care" nature of the fabrics. Treated fabrics should be laundered in accordance to instructions as these may recommend lower heat settings during drying and ironing.
Applications	Suits
Applications	Heavy weight fabrics such as suiting, lightweight fabrics for shirting are not readily available.
End of life Possibilities.	Can be disposed of using all end of life opportunities
End of life Possibilities.	A natural cellulose fibre that can be handled in the same way as other cellulose fibres. The fabrics may potentially be re-used or re-manufactured and can also be used as a source of cellulose feedstock for regenerated cellulose products. Being naturally biodegradable, the fibres can be composted if required.
Cost scope (economic impact)	
Common trade names	

Alternatives	
Specialists	Ryszard Kozlowski, PhD, Institute of Natural Fibres, ul. Wojska Polskiego 71b, 60630 Poznan, Poland.

13.11 Nettle data sheet.

13.11.1 Property summary for nettle fibres.

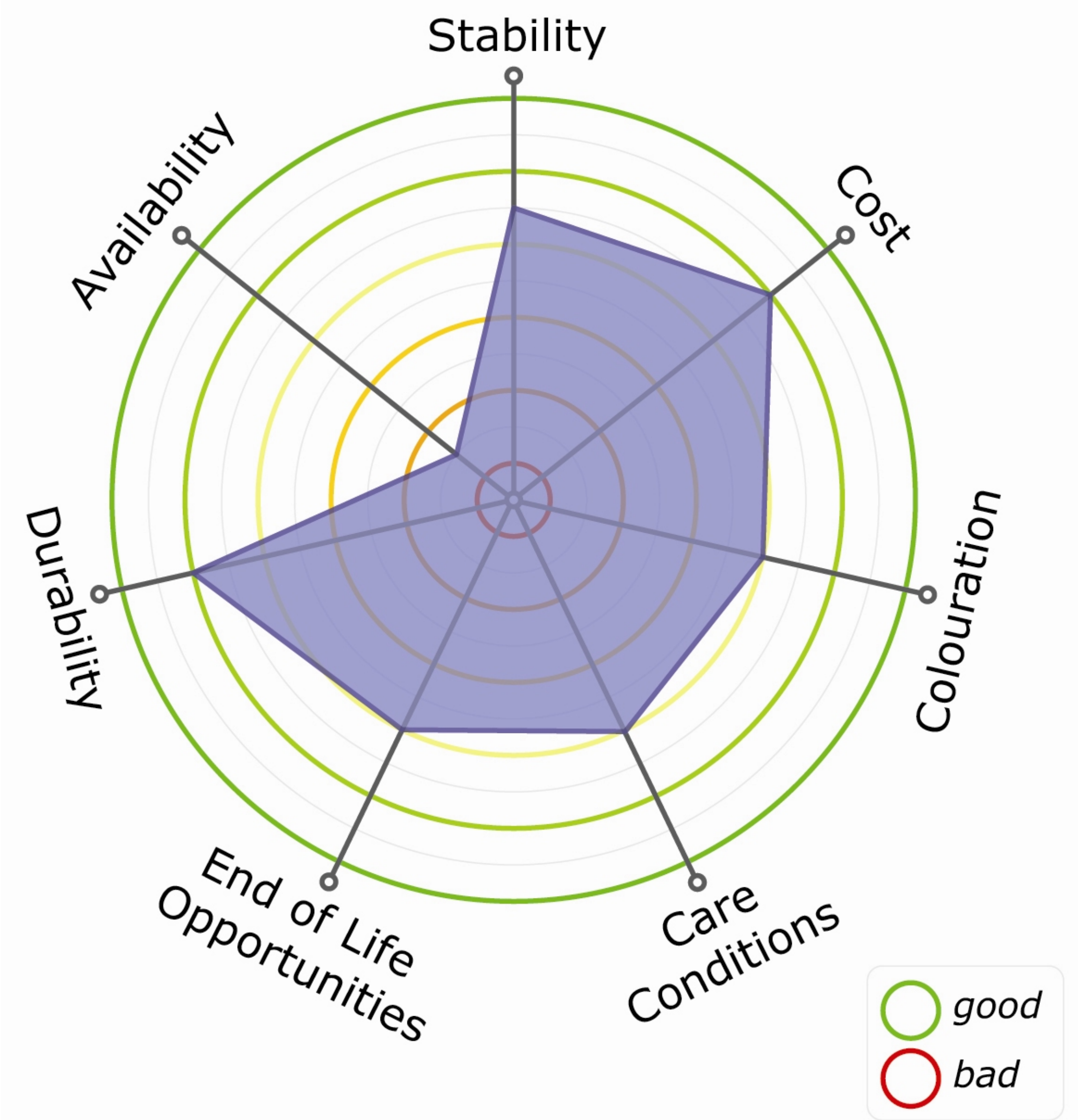

Figure 44 Property summary for nettle.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.11.2 End of life Opportunity summary for nettle fibres.

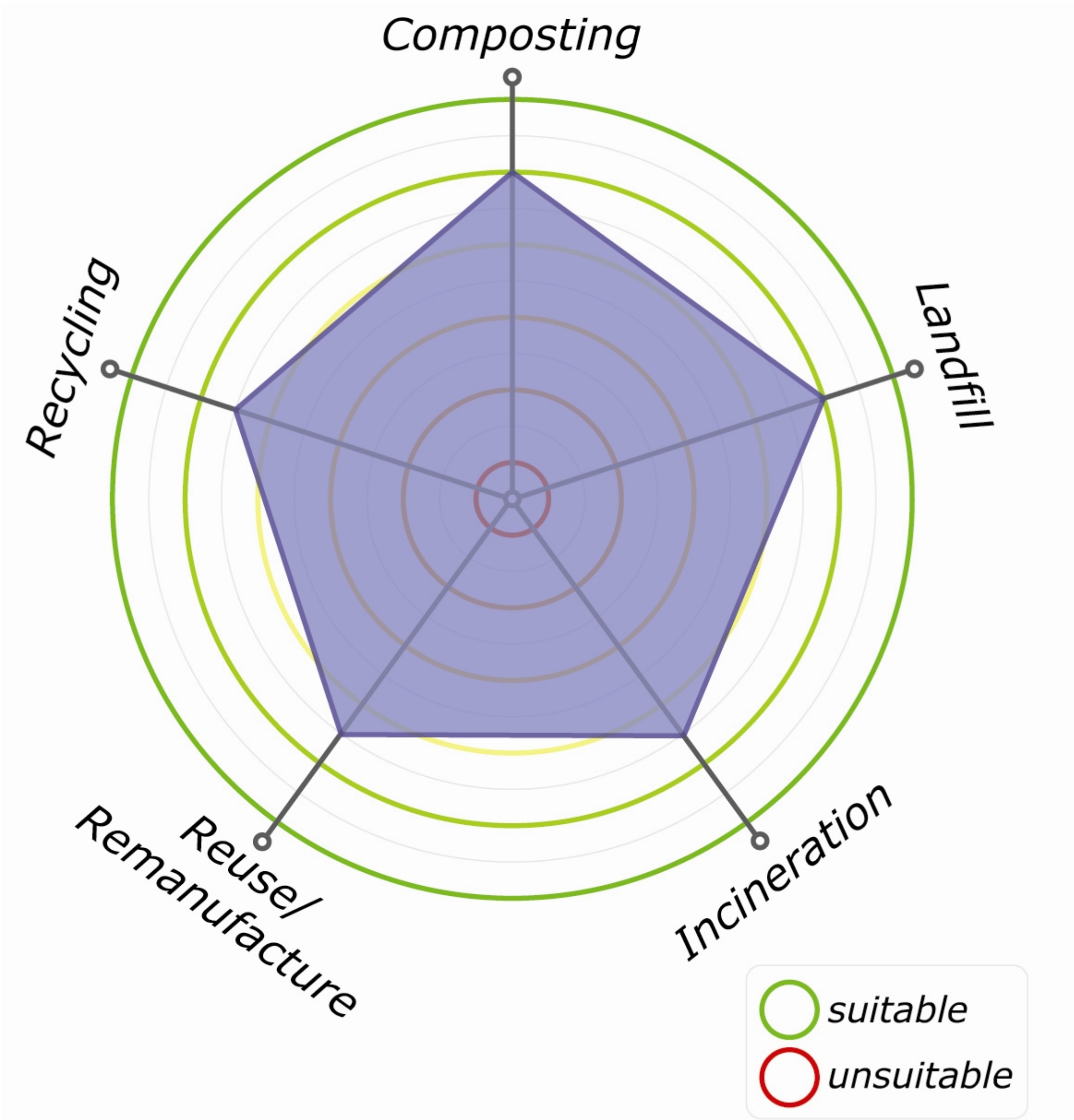

Figure 45 End of life opportunities for nettle.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.11.3 Data sheet for nettle fibres.

	Nettle
General	Natural cellulosic fibre
General	A hard wearing fibre that has a degree of natural flame resistance and grown and processed in the UK. Currently only available in extremely limited volumes which are being blended with wool and used in upholstery fabrics.. It is unlikely to be in a position where sufficient fibre will be available for use in garments.
Available as:	Currently very limited in the UK
Available as:	Nettle fibres are currently only available in restricted amounts. Used as mixed fibre blends, nettle is finding some applications in apparel where it is extremely hard wearing and durable. Volumes of fibre that are currently on the market are extremely small and limited. Incorporation into corporate clothing will take time to develop.
Colouration	Needs to bleach prior to dyeing, treat as cellulose
Colouration	Nettle naturally has an off-white colour and will therefore require bleaching prior to any dyeing. Hydrogen peroxide bleaching as preparation of the fibre irrespective of the ultimate shade as this preparation route removes most of the extraneous matter in the fibre facilitating better levelling during the dyeing process. The natural colour nettle is often too deep to respond completely to the hydrogen peroxide treatment and a two stage sodium hypochlorite bleach then the hydrogen peroxide bleach is required. This is especially the case when light colours are requ8ired. Nettle, like other natural cellulosic fibres, can be dyed with reactive dyes or in some cases direct dyes. If the clothes are to be used for work wear where more durable dyes are likely to be required, reactive dyes, vat dyes or sulphur dyes would be the selection of choice.
Dimensional Stability	shrink resistant
Dimensional Stability	Good dimensional stability, fibres tend to have higher strength when wet than dry.

Resistance to pilling	resistant to pilling
Resistance to pilling	Nettle fibre are extremely durable and resistant to abrasion and pilling.
Moisture regain	Typically 5-8%.
Moisture regain	Typically 5-8%.
Care information	can be laundered at high temperatures, prone to creasing
Care information	Nettle can withstand laundering at high temperatures, these should only be used for heavily soiled garments. Flax fabrics are prone to becoming creased during washing and this will requires the use of a hot (steam) iron during pressing. Dyes have a tendency to bleed and suitable separation during washing should be encouraged. Chlorine based bleaches can be safely used on cotton, although dyed fabric should use a colour safe bleach. Tumble-drying requires a high temperature setting. Like cotton, nettle can be treated with a crease resistant finish which can improve the "easy care" nature of the fabrics. Treated fabrics should be laundered in accordance to instructions as these may recommend lower heat settings during drying and ironing.
Applications	jackets and suiting
Applications	Blended with other fibres it can be used in some apparel such as dresses. Current heavy weight fabrics more suitable for jackets where hard wearing properties can be exploited
End of life Possibilities.	Can be disposed of using all end of life opportunities
End of life Possibilities.	A natural cellulose fibre that can be handled in the same way as other cellulose fibres. The fabrics may potentially be re-used or re-manufactured and can also be used as a source of cellulose feedstock for regenerated cellulose products. Being naturally biodegradable, the fibres can be composted if required.
Cost scope (economic impact)	

Common trade names	
Alternatives	
Specialists	Dr Matthew Horne Senior Research Fellow TEAM Research Group Gateway House, De Montfort University The Gateway Leicester LE1 9BH tel +44 (0) 116 257 7550

13.12 *Lycra data sheet.*

13.12.1 Property summary for lycra

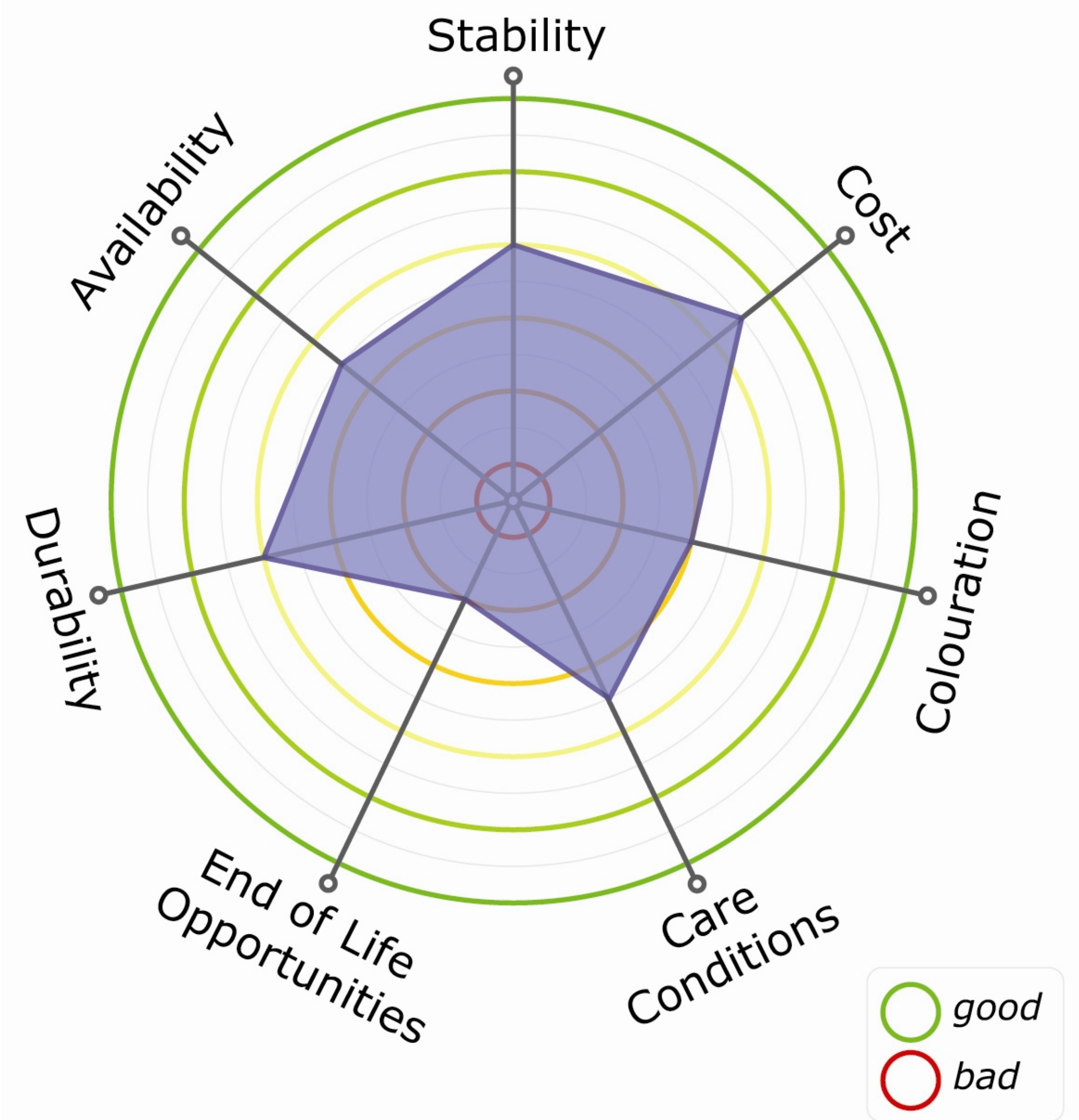

Figure 46 Property summary for lycra.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.12.2 End of life Opportunity summary for lycra

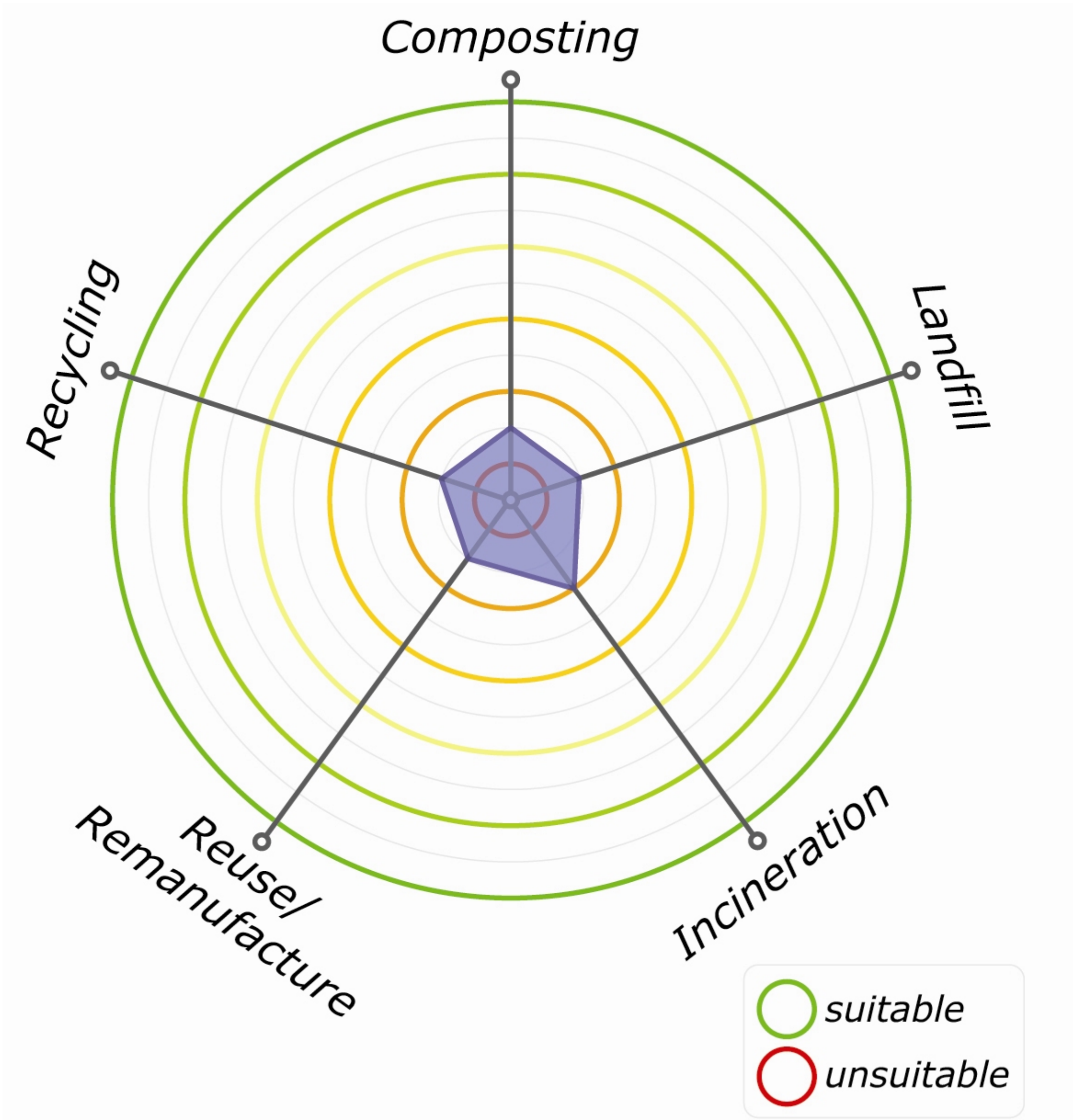

Figure 47 End of life opportunities for lycra.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.12.3 Data sheet for lycra

	Lycra
General	Electrometric fibres
General	Lycra is an elastomeric fibre that is found blended with other fibres to improve the stretch and fit of fabrics. Within the corporate clothing sector Lycra will only be found blended.
Available as:	present in blended yarns
Available as:	present as minor constituents in a wide range of blended yarns that are used in knitted and woven fabrics.
Colouration	easy to dye
Colouration	Elastane fibres can be readily dyed
Dimensional Stability	elastic fibre, with good recovery
Dimensional Stability	Very elastic but returns to original dimensions after stretch & washing. Improves the stability of blended yarns
Resistance to pilling	resistant to pilling
Resistance to pilling	resistant to pilling
Moisture regain	less than 2%
Moisture regain	low , less than 2%
Care information	launder using majority fibre conditions, avoid chlorine bleaches.

Care information	Garments made entirely from or containing Lycra and other similar elastomers should be washed in lukewarm water. It is recommended that these fibres should not be subjected to bleaching, especially chlorine based bleaches. If any bleaching is necessary then suitable colour safe bleaches must be used. Natural drying is recommended though the use of low temperature tumble-drying can be carried out. Ironing when required should be carried out using a low temperature setting on the iron and should be performed quickly. Leaving the iron too long in one place will result in damage to the fibre.
Applications	widely used in blended yarns
Applications	Lycra is not used as 100% in fabric form in the corporate clothing sector. It will be used as a minor component in blended yarns using as little as 2%. The presence of Lycra results in a general improvement of the fabric properties and will find applications in a wide range of knitted and woven garments
End of life Possibilities.	Avoid composting
End of life Possibilities.	The fibres tend to be UV resistant and the fibres take a considerable time to break down. Other end of life options are applicable.
Cost scope (economic impact)	
Common trade names	Lycra, Spandex
Alternatives	
Specialists	Du Pont (U.K.) Limited Wedgwood Way Stevenage Herts SG1 4QN Tel: + 0044 (0) 1438 73 4000 Fax : + 0044 (0) 1438 73 4836

13.13 Cotton-polyester blends data sheet.

13.13.1 Property summary for cotton-polyester blends

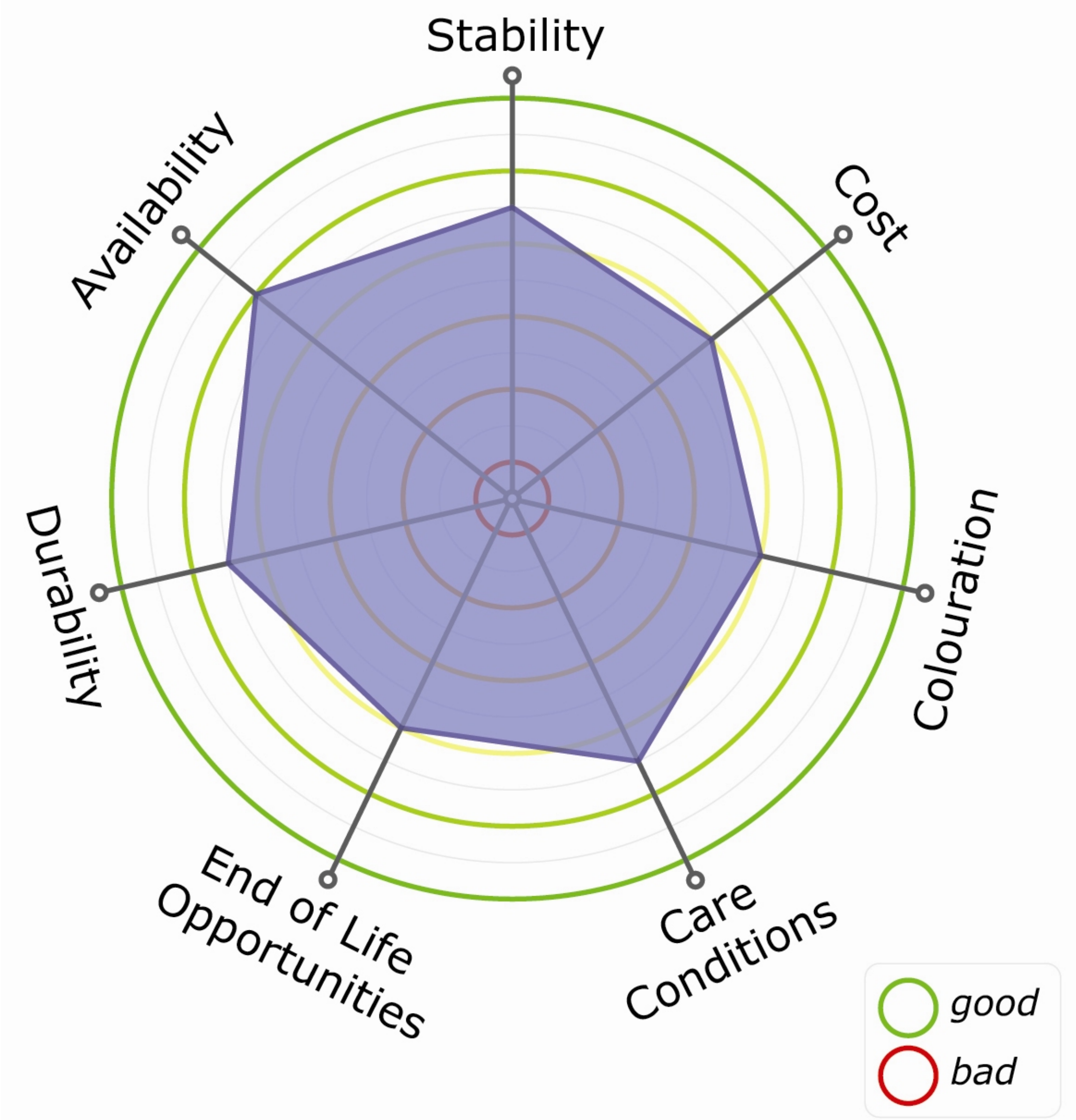

Figure 48 Property summary for cotton/polyester blends.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.13.2 End of life Opportunity summary for cotton-polyester blends

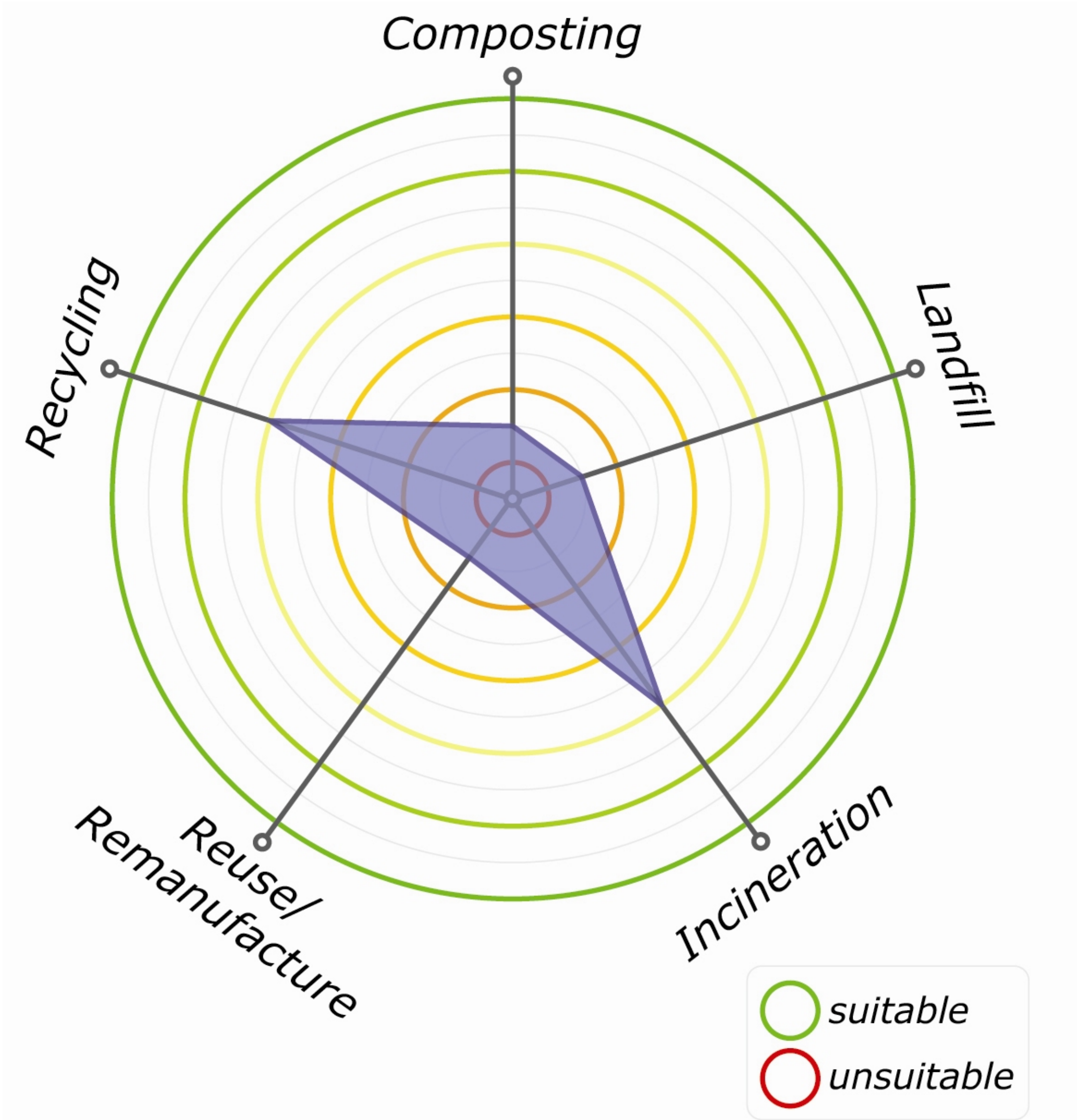

Figure 49 End of life opportunities for cotton/polyester blends.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.13.3 Data sheet for cotton-polyester blends

	Cotton/polyester blends
General	Natural & synthetic fibre blend
General	Cotton & polyester blends combine the best of the properties of both fibres to provide a fabric that has easy care qualities with the comfort afforded by the moisture absorption characteristics of cotton.
Available as:	widely available
Available as:	Widely available in a range blends and an equally wide range of fabric weights
Colouration	Can be dyed a wide range of colours
Colouration	The bleaching and dyeing characteristics of the two fibres do differ and it is likely that a combined programme will be required to achieve the colouration required. Neither fibre is difficult to process
Dimensional Stability	Very low shrinkage
Dimensional Stability	The presence of polyester improves the already good performance of cotton
Resistance to pilling	resistant to pilling
Resistance to pilling	The presence of the polyester in the blend brings about an improvement to the pilling resistance
Moisture regain	blend dependant
Moisture regain	Will depend on the blend composition and be between the low levels attainable with polyester to the moderate levels for cotton, 2-12%
Care information	Easy care, warm wash, gentle iron.

Care information	The easy care properties associate with polyester overcome the difficulties that can be attributed to cotton. As with many properties the overall performance will depend on the blend ratio. With the higher polyester concentrations the care becomes easier. High temperature laundering can be undertaken if required.
Applications	Wide range of applications
Applications	Cotton & polyester blends find applications in almost all areas associated with "image wear" in the corporate clothing sector. Lightweight fabrics are used in shirts/blouses and heavier weights can be used for skirts & trousers.
End of life Possibilities.	Restricted because of blend
End of life Possibilities.	Being a blended yarn does impose some difficulties on the end of life opportunities. Separation of the fibres is one of the biggest barriers preventing either fibre from being recycled or remanufactured. Re use as a blended fabric is restrictive and the stable nature of polyester prevents the fabrics from going into composting.
Cost scope (economic impact)	
Common trade names	
Alternatives	
Specialists	Carrington Career & Workwear Ltd, Market Street Adlington Nr Chorley Lancashire PR7 4HJ Tel: +44 (0) 1257 476 850 Fax: +44 (0) 1257 476 863 Email: info@carrington-cww.co.uk

13.14 *Wool & acrylic blends data sheet.*

13.14.1 Property summary for wool & acrylic blends

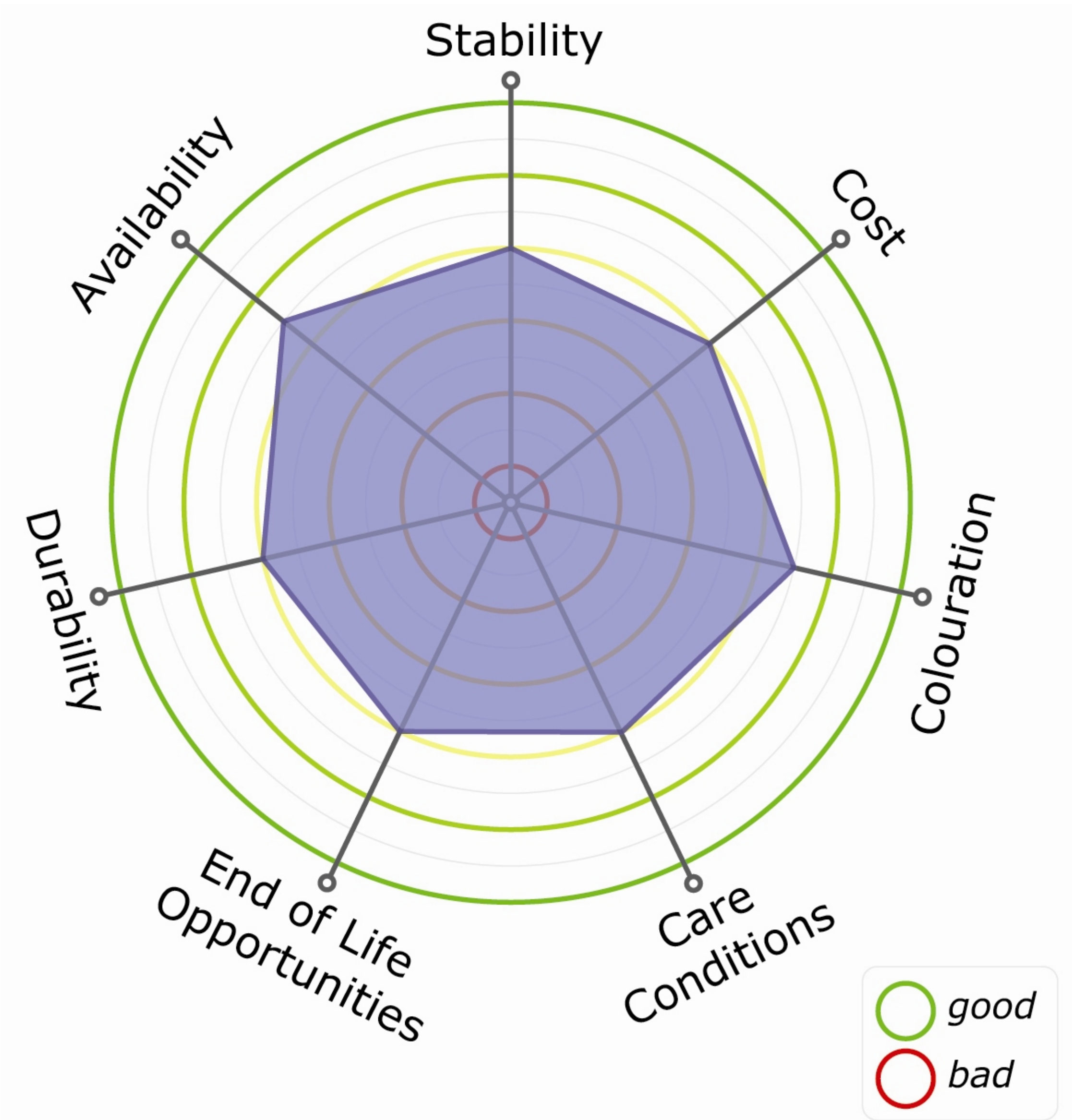

Figure 50 Property summary for wool/acrylic blends.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.14.2 End of life Opportunity summary for wool & acrylic blends

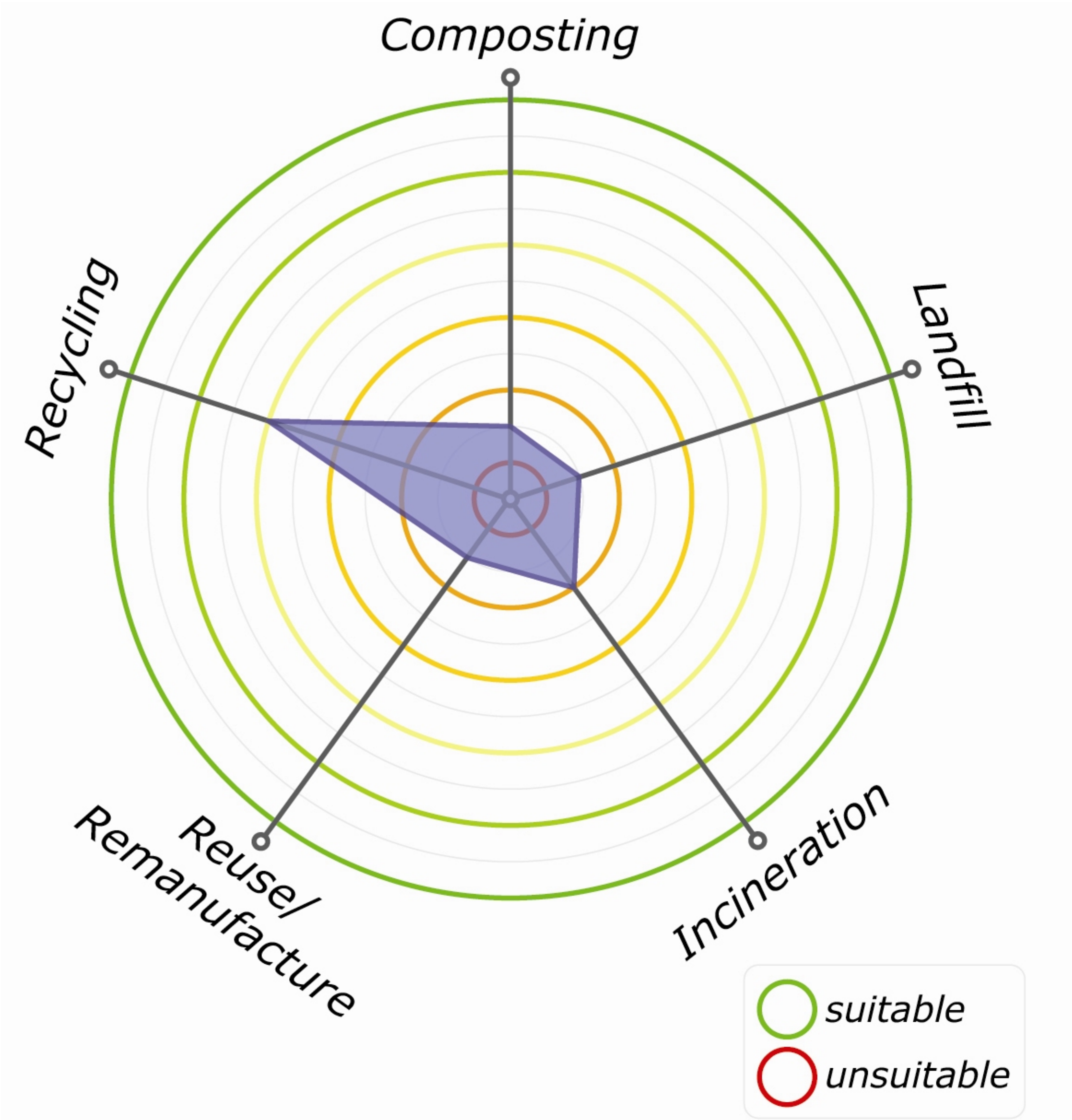

Figure 51 End of life opportunities for wool/acrylic blends

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.14.3 Data sheet for wool & acrylic blends

	Wool/acrylic blends
General	Natural fibre/synthetic fibre blend
General	The blend combines the thermal properties of both fibres, being aboe to provide bulk that can enhance thepotential insulation. As with all blends the properteis will be influenced by the composition
Available as:	
Available as:	
Colouration	
Colouration	
Dimensional Stability	More stable than wool
Dimensional Stability	The presence of the acrylic fibre will help to stabilise the dimensional stability of the fabrics. The effect will depend on the blend ratio, the higher the level of acrylic fibre the lower the amount of shrinkage is likely to be.
Resistance to pilling	
Resistance to pilling	
Moisture regain	
Moisture regain	
Care information	
Care information	
Applications	
Applications	Generally used in knitwear

End of life Possibilities.	
End of life Possibilities.	
Cost scope (economic impact)	
Common trade names	
Alternatives	

13.14 *Cotton & lyocell blends data sheet.*

13.14.1 Property summary for cotton & lyocell blends

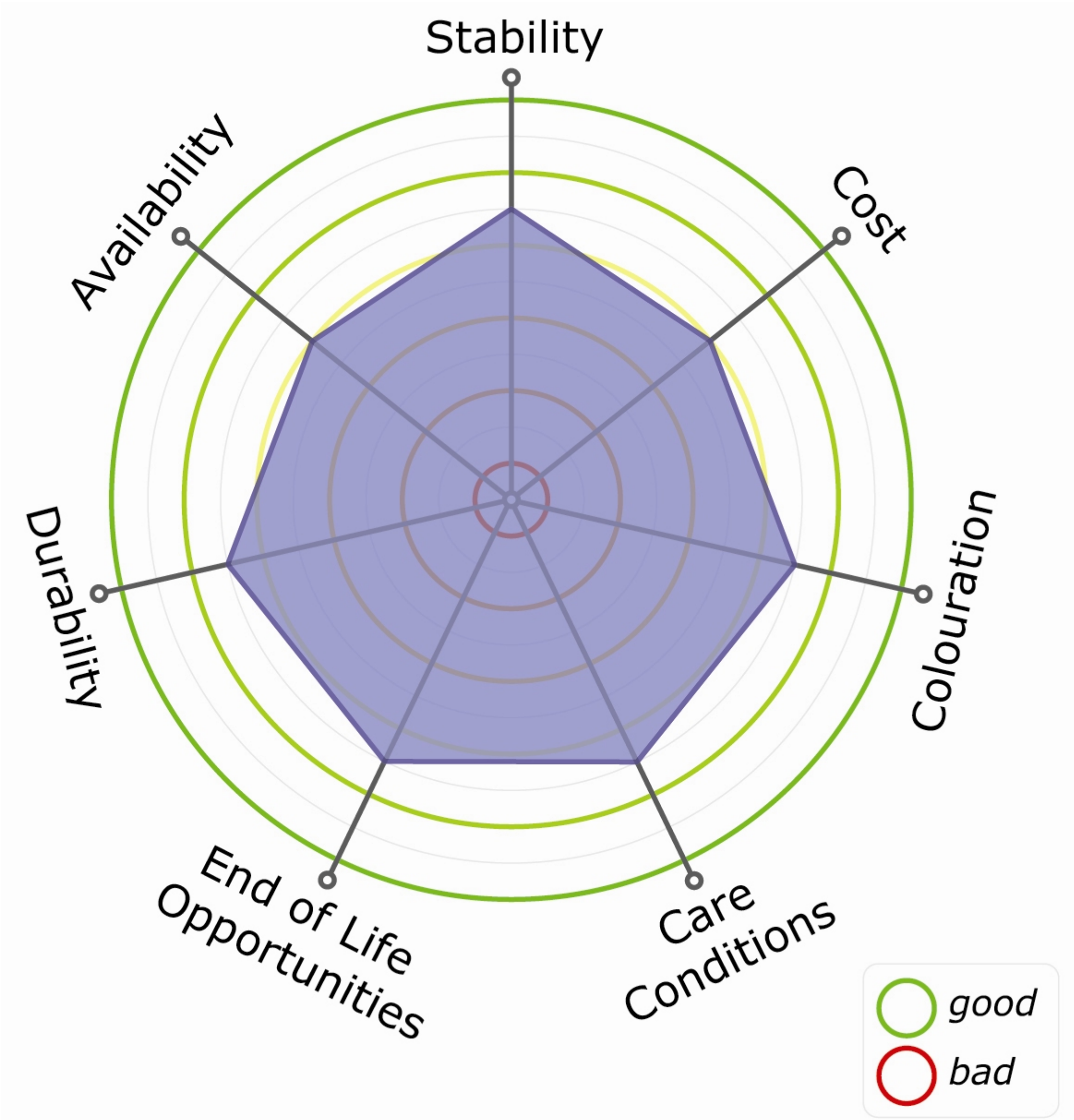

Figure 52 Property summary for cotton/lyocell blends.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.14.2 End of life Opportunity summary for cotton & lyocell blends

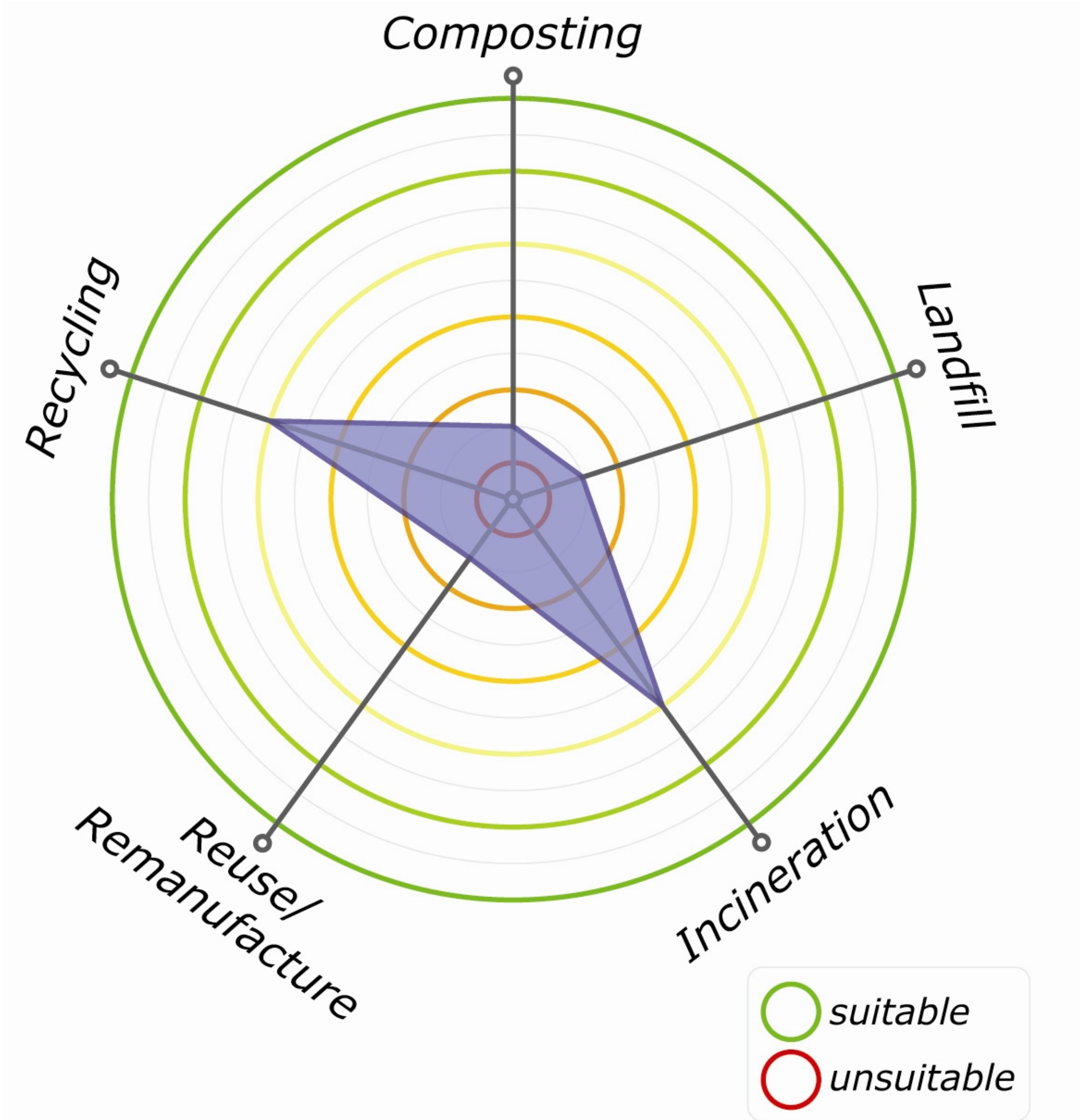

Figure 53 End of life opportunities for cotton/lyocell blends

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.14.3 Data sheet for cotton & lyocell blends

	Cotton/lyocell blends
General	Natural/regenerated Cellulose blend
General	Cotton and lyocell are blended together in a range of ratios and this takes advantage of the characteristics of both fibres. The presence of lyocell is often seen as a means of improving the "eco friendly" nature of the fabric and extending the capacity of cotton to meet market requirements.
Available as:	Range of blend ratios and fabric weights available knitted and woven
Available as:	Cotton & lyocell blends are available as a range of blend ratios. This will influenced by the application. In addition to the range of compositions, a wide range of fabric weights can be obtained. Woven fabrics are the most common however knitted cotton/lyocell blends are used.
Colouration	Treat as cotton
Colouration	Since both fibres are cellulose based, dyeing the blended fabrics does not produce any problems. Pre-treatment bleaching carried out using a peroxide bleach is normally recommended and provides a basis for dyeing with a wide range of colours that includes very pale shades.
Dimensional Stability	Very low shrinkage
Dimensional Stability	The presence of lyocell in the blends provides enhanced dimensional stability to cotton
Resistance to pilling	Satisfactory resistance to pilling.
Resistance to pilling	Cotton and lyocell can both fibrillate and this can result in the presence of some pilling. The use of low fibrillating grade of lyocell or the application of suitable treatments reduces this effect and provides a resistant fabric.
Moisture regain	blend ratio dependent between 10-25%

Moisture regain	This will be influenced by the blend ratio. With lyocell having double the moisture regain capacity of cotton, higher amounts of lyocell will increase the level of moisture regain. Levels between 10 and 25% can be expected
Care information	Prefers warm washing but can withstand high temperature wash
Care information	Both lyocell and cotton can withstand high temperature laundering however warm washes are usually less severe and less likely to cause creasing. Both fibres can be tumble dried. Creasing will require ironing and the intensity will relate to the level of cotton in the blend.
Applications	all applications where cotton is used.
Applications	The use of cotton/lyocell blends in the corporate clothing sector is still developing. The fabrics are suitable for lightweight end uses such as shirts and leisure wear. Heavier weight fabrics can find uses wherever cotton fabrics have been used.
End of life Possibilities.	Can be disposed of using all end of life opportunities
End of life Possibilities.	Both cotton and lyocell are biodegradable but they have the potential to be reused in other ways. Re-use in most ways will be dependant upon the removal of corporate identities such as logos. Some applications will also require the removal of fastenings such as buttons and zips. As complete garments, the reuse in similar roles, for example in third world countries, offers one possibility. In fabric form it can be recycled into wipes for use in a variety of industrial sectors and shredded to be used as mattress infill or into insulation for buildings. Since both fibres are cellulose the blends can be used as a source of raw material for the manufacture of regenerated cellulose fibres.
Cost scope (economic impact)	
Common trade names	
Alternatives	

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13.16 Wool/ polyester blends data sheet.

13.16.1 Property summary for wool/polyester blends

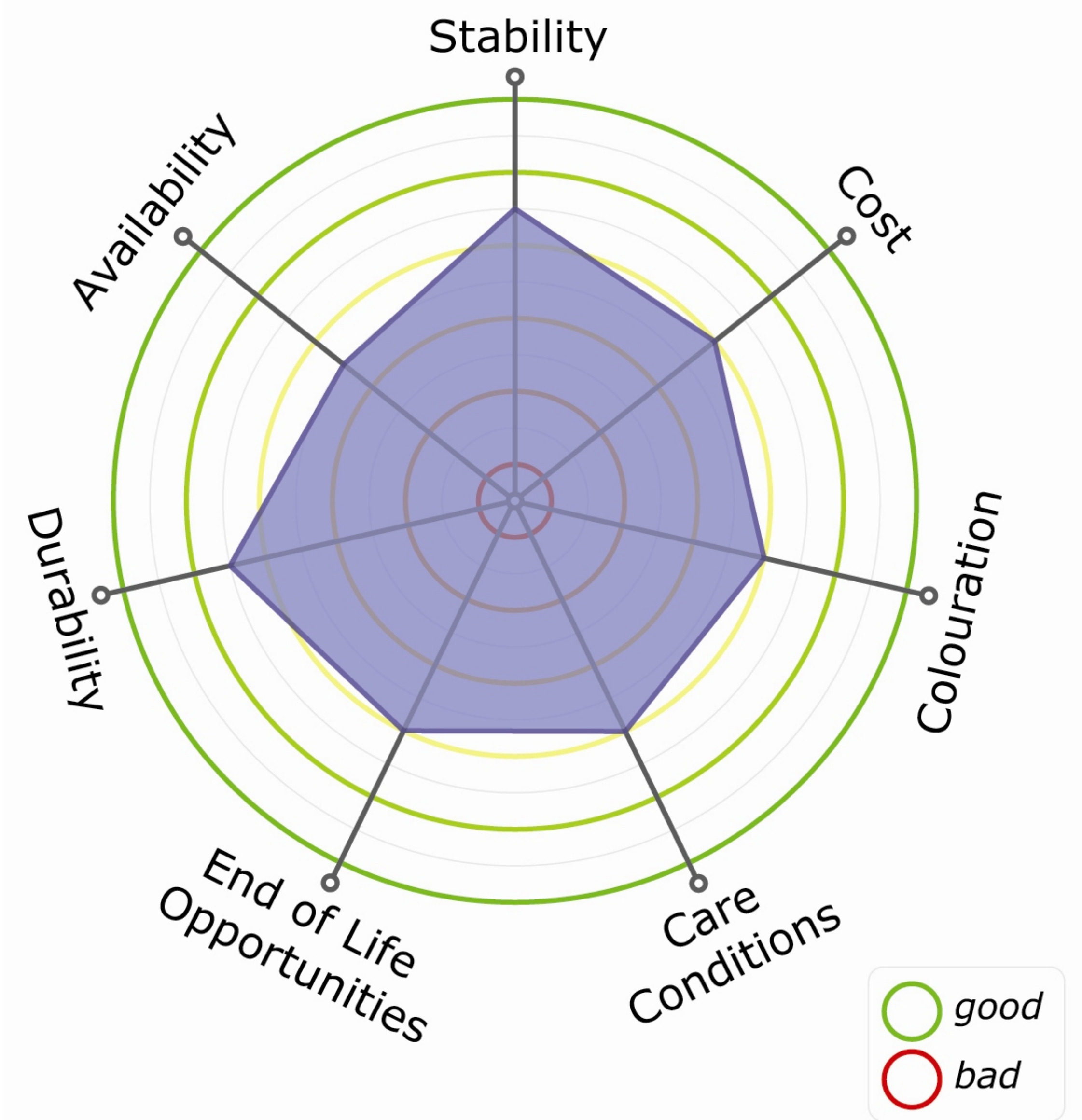

Figure 54 Property summary for wool/polyester blends.

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.16.2 End of life Opportunity summary for wool/polyester blends

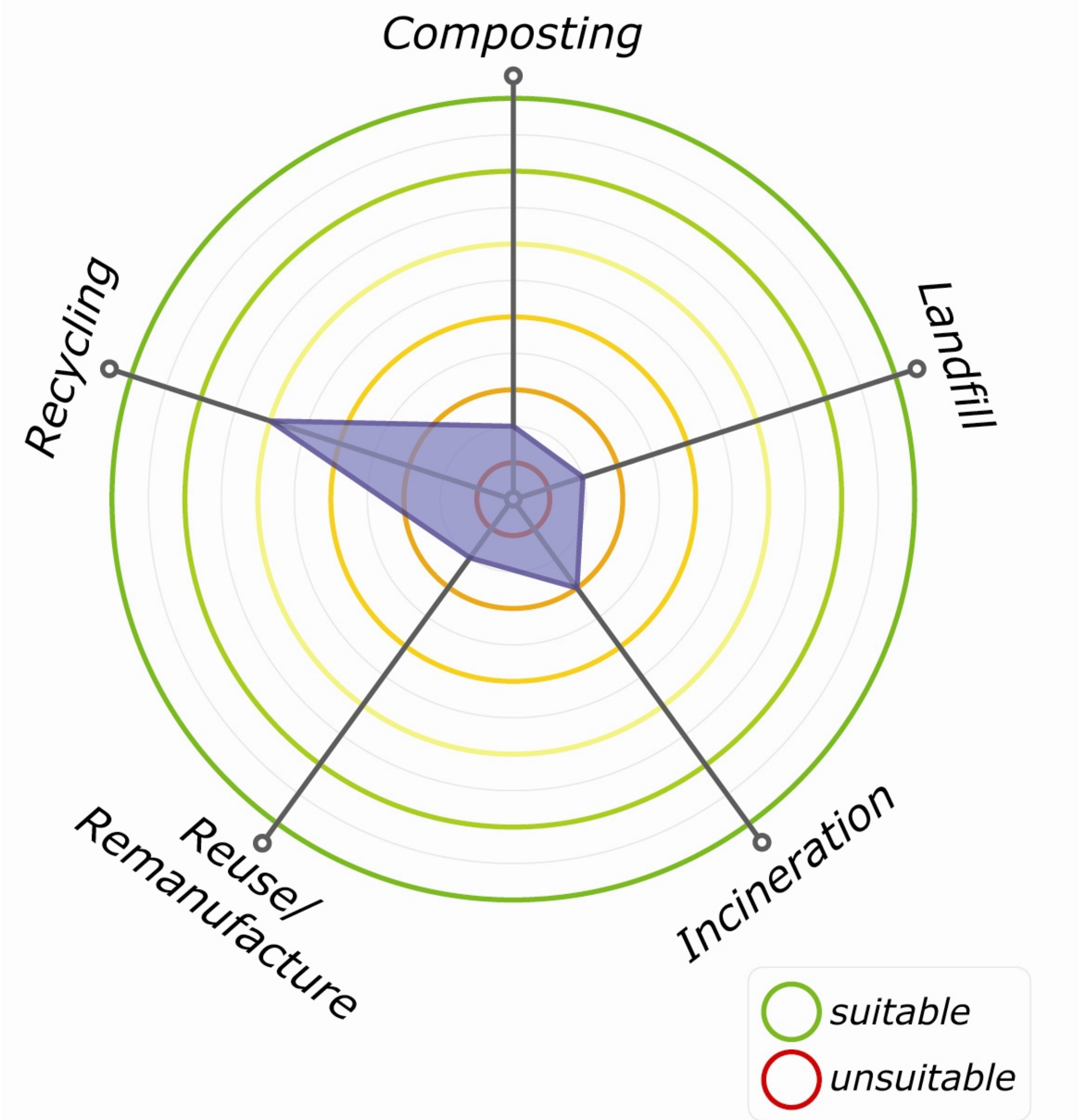

Figure 55 End of life opportunities for wool/polyester blends

Characteristics / options defined by the above graph are proportionally represented and approximate, and are only intended as a guide. As such they do not represent any industry standards. Among other things, fabric construction and weight will influence the perceived ranking.

13.16.3 Data sheet for wool & polyester blends

	Wool/acrylic blends
General	Natural fibre/synthetic fibre blend
General	The blend combines the thermal properties of both fibres, being aboe to provide bulk that can enhance thepotential insulation. As with all blends the properteis will be influenced by the composition
Available as:	
Available as:	
Colouration	
Colouration	
Dimensional Stability	More stable than wool
Dimensional Stability	The presence of the acrylic fibre will help to stabilise the dimensional stability of the fabrics. The effect will depend on the blend ratio, the higher the level of acrylic fibre the lower the amount of shrinkage is likely to be.
Resistance to pilling	
Resistance to pilling	
Moisture regain	
Moisture regain	
Care information	
Care information	
Applications	
Applications	Generally used in knitwear
End of life Possibilities.	

End of life Possibilities.	
Cost scope (economic impact)	
Common trade names	
Alternatives	