# Wool Production, Processing and Use - Environmental Aspects

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**Abstract:** Wool is a natural and renewable protein fibre, however natural and renewable does not automatically equate to 'sustainable' and 'environmentally friendly'. Wool, like most other mainstream textile fibres, must examine its environmental credentials to meet the growing demand for ethical and sustainable textiles by the consumers, 'brands' and retailers from the major markets in Europe, Japan and North America.

The merits of different environmental claims such as 'eco-' and 'organic' will be discussed, noting the value of Type 1 ecolabels such as the EU ecolabel in validating environmental claims. The International Wool Textile Organisation (IWTO) has restricted use of the term 'eco-wool' to wools that comply with the EU ecolabel standard at all stages of processing and production.

The environmental impacts associated with Australian wool production, processing and use will be compared using a life cycle assessment (LCA) approach. While some caution must be used in interpreting LCA results, the process can provide useful insights for comparing the major environmental impacts associated with production, processing and use of wool and other fibres.

**Keywords:** eco-wool; eu ecolabel; life cycle assessment (lca); organic.

## 1 Introduction

Wool is a natural and renewable protein fibre with a high quality image. These qualities should make wool products highly attractive to the growing numbers of environmentally aware consumers in the major northern hemisphere textile markets of Europe, Japan and Northern America. In these countries, despite the global financial crisis of 2009/10, the demand for ethical and environmental goods and services continues to remain high [1].

Currently, global environmental leadership is coming from Europe. Increasingly it is European legislation that is influencing global manufacturing [2]. The REACh legislation (Registration, Evaluation, Authorisation and Restriction of Chemical substances, EU Regulation, 2006) is beginning to impact on the acceptability of chemicals used worldwide, in the event that manufactured products may find their way to Europe. The US is proposing its own REACh-like legislation [3]. European retailers are increasingly developing programs to differentiate their profile on environmental and ethical grounds and therefore traceability is important [1]. Wal-mart, the largest global retailer, is beginning to impose its own ethical and environmental requirements on its suppliers.

As with all textile processing, there are wool processing mills that operate to the highest environmental and ethical standards, and there are mills that adopt lower standards. To support the development of the best environmental operators, in 2008 the International Wool Textile Organisation (IWTO) allowed use of the term 'eco-wool' for wools that comply with the EU ecolabel standard at all stages of processing and production.

To address the ethical concerns associated with animal welfare practices, in 2010 the IWTO announced that it has begun consultation on the introduction of a globally acceptable, code of best practice related to environmental and animal welfare during the production of wool fibre [4].

## 2 Discussion

### 2.1 Environmental claims

(a) The most consistent requests from European consumers and retailers are for traceability of supply chains and for validation of environmental claims. Ecolabels are designed to provide some of this information, however not all ecolabels have the same meaning. This is an area of great confusion in the marketplace.

In general, ecolabels can be divided into three classes, Type I, Type II and Type III. These descriptions are based on ISO Standards. Type I and Type II are the most common. Claims based on Type I ecolabels (as described by ISO 14024) are by far the most credible. Type I labels are based on transparent and independently established criteria that apply across the life cycle of a product. Compliance is certified or audited by an independent third party. The EU ecolabel is a good example of a Type I ecolabel.

Type II claims are based on ISO 14021 and are essentially self declarations by manufacturers or retailers. Unfortunately Type II claims often present difficulties in terms of verifiability and credibility. This is the province of 'Greenwash' where companies or products pretend to be more environmentally friendly than they are. Consumers often do not distinguish between Type I and Type II claims and they assume that all environmental claims have some kind of official backing [5]. Type III labels are little used.

(b) What differentiates organic-, biodynamic-, eco-, sustainable- and ethical wools?

The terms 'Organic' and 'Biodynamic' are a form of Type I ecolabel, characterised by independent and transparent criteria and subject to third party audits. The terms are strictly controlled in most countries, although the criteria may differ significantly between countries and even between accrediting agents within the same country. These labels, when applied to wool, imply that only natural materials are used in the production and processing of the fibre, but in fact some organic accrediting agencies allow use of 'allopathic medicines' (synthetic pesticides) for treatment of pest infestations of sheep. The Global Organic Textile Standard (GOTS) is an important 'organic' standard for production and processing of textile products, however it allows extensive use of synthetic dyes, detergents and processing additives, albeit with strict criteria on safety. Environmental discharge limits are similar to the EU ecolabel except for wool scouring where there are currently no limits imposed.

The term ‘eco-wool’ has now been defined by IWTO as wool that meets the EU ecolabel requirements, and that also meets local environmental discharge requirements. Various forms of the term ‘eco-wool’ have been trademarked and used for marketing purposes but these wool products may not comply with the requirements of the above Type I ecolabels and IWTO regulations now restrict the use of such terminology in the wool industry.

The terms ‘sustainable’ and ‘ethical’ wools have no defined context and supporting evidence should be sought to identify the specific basis of such claims.

Type I ecolabels are the most rigorous. Some ecolabels, especially in textiles, may only be concerned with single issues, such as ecolabels that ensure that fair wages have been paid to all workers in the supply chain. The market leading textile ecolabel, the Oeko-tex 100 label, deals solely with the absence of arbitrary concentrations of toxic agents in the final garment, although it is being applied at different stages in the supply chain. Oeko-tex 100 is silent on environmental discharges in textile processing, although other less popular labels in the Oeko-tex family have requirements.

(c) The EU ecolabel

The EU ecolabel is arguably the most important standard for good environmental processing of textile fibres. It applies to all fibres and contains criteria that exceed ‘environmental best practice’ for textile processing as defined in the EU BREF document [6] and the EU Integrated Pollution Prevention and Control (IPPC) legislation. Other international Type I textile ecolabels have often taken their criteria from the EU ecolabel.

The EU ecolabel includes three groups of criteria:

1. All fibres have a clean fibre requirement. For natural fibres, the clean fibre criteria are based on pesticide content;
2. The fibres must be processed using low environmental impact processing conditions (safe chemicals must be used, detergents must be biodegradable and there are strict limits on discharges of effluents and toxic materials);
3. There are ‘fitness for use’ criteria that guarantee that the product will be durable. This provides an assurance to consumers, but it also reduces the environmental impacts associated with processing of a replacement garment.

Some of the derived Type 1 standards (including the GOTS) include some social elements (fair pay, safety, child labour) and the EU ecolabel itself is developing criteria. Type 1 ecolabels, because they are more rigorous and may cover entire supply chains, are viewed as more difficult to comply with than other types. Russell [7] summarises some of the compliance requirements for the EU ecolabel in wool supply chains and Cai *et al.* [8] in this conference describe implementation of the criteria in Chinese wool mills.

## 2.2 The environmental profile of Australian wool

All textiles are seeking to demonstrate their ethical and environmental credentials. One important tool for comparing the environmental credentials of different textile fibres is Life Cycle Assessment (LCA), a process that can, in principle, identify and quantify the environmental impacts of any operation or process. A very wide range of environmental impacts that range from use of mineral resources to air quality may be evaluated.

The factors most commonly considered are water, energy, and fossil fuel usage and production of greenhouse gases (GHGs). There are many gases that contribute to global warming, including some which are many times more potent than $CO_2$ itself. The Intergovernmental Panel on Climate Control (IPCC) has established factors for the global warming potential (GWP) for emissions of other gases relative to $CO_2$ itself ($CO_2$ has a defined GWP of 1). Because natural fibres like wool and cotton are produced from agriculture, methane (with a GWP factor of 25 based on a 100 year time horizon) and nitrous oxide (with a GWP of 298) are the most important [9]. The overall emissions are expressed as $CO_2$-equivalents (or $CO_2$-e).

The results produced from LCA studies on textiles can be considered in 3 stages;

- production of cleaned, aligned fibre,
- textile processing, and
- product use and disposal.

Wool differs from most fibres in that significant processing stages (scouring, carding) are required to produce cleaned fibres ready for blending and spinning.

Russell in 2009 provided an initial LCA of Australian wool, from fibre production to garment disposal and recycling [10]. Australian wool is produced in many different climates and conditions, it is processed in many countries and because it is manufactured into a variety of garment types, three specific scenarios were used to allow collection and assembly of data:

1. Superfine wool produced in a high rainfall climate and processed into next-to-skin knitwear in Italy;
2. Fine wool produced on a mixed enterprise farm and processed in China to men's suiting, and
3. Slightly coarser wool was produced in an arid climate and processed in China into outer knitwear.

All finished garments were assumed to be sent to Europe by ship and worn and disposed there.

Such a study is data-intensive and requires many assumptions. In establishing the LCA, the farming inputs (water, land use, feed, fuel and fertiliser) and the main environmental impacts (methane from enteric digestion and manure, nitrous oxide from fertiliser and urine) need to be allocated between the two main products from the sheep (meat and wool). Sheep are increasingly being produced as dual purpose animals and many farmers make economic decisions on the most profitable use of the animals. Sheep with superfine wools are produced predominantly for their higher value wool, while sheep with coarser wools tend to be valued for their meat. For this reason, the allocation of farm inputs and outputs between sheep meat, wool and other farm outputs was made on economic grounds. There are many difficult issues that surround all LCAs that involve agriculture and these are the subject of intensive research.

The energy used in sea transport of raw wool and wool goods is low compared with road and air freight.

When textile processing stages were considered, the energy and water required to process wool (spin, weave/knit, dye, finish, garment makeup) were broadly similar to all other fibres. Because wool is a more fragile fibre than many synthetic fibres, it cannot be processed in the most modern, energy efficient, low liquor ratio, high pressure machines. However industrial practices between mills vary widely.

Recent studies have shown that, for many fibres, the environmental impacts associated with garment care can dominate the life cycle water and energy impacts. This is particularly true for the high energy wash/tumble dry/press care cycles common in cooler northern hemisphere countries. Wool goods tend to be expensive, and this means that consumers tend to dryclean wool garments or wash wool goods at lower temperatures and often avoid tumble drying. With its good odour absorbing properties, wool goods may be washed less frequently. These factors reduce the environmental impacts in the use phase for wool.

The high cost of wool ensures that there is a ready market for fibre wastage from manufacture, and wool garments also tend to be durable. These factors may lead to more wool goods being recovered and recycled than cheaper garments. Russell's study showed small environmental impacts associated with disposal of wool goods in the highly managed land-fill or incineration systems in Europe.

While it is relatively easy to calculate the energy used in processing textiles, it is often more difficult to calculate the associated emissions of $CO_2$. In Europe, where renewable energy sources are used extensively, only about 25% of electricity is produced by burning coal. In China, the $CO_2$ emissions from every kilowatt of electricity, extensively derived from coal, are much higher. In Europe, natural gas is widely available as a source of thermal energy, and this can be efficiently burned in direct-fired equipment and driers. In China, thermal energy is largely available as steam from nearby electricity generators or from less efficient in-factory boilers. With additional energy losses from distribution of the steam, the emissions of $CO_2$ from an equivalent textile operation can vary widely with plant location.

There are many other factors that can influence the results of LCA studies and it is always important to examine closely the inherent assumptions (as an example, has the energy to operate the air conditioning and effluent treatment plant been included?), the system boundaries (have significant inputs been ignored, are geographical factors important, have some outcomes not been reported?), the purpose of the study (is it used for marketing purposes or to demonstrate that one fibre is better?), and, most importantly, was the study conducted by an independent body and/or was it sponsored by a group with a special interest in the outcome?

The function of a LCA should be to objectively inform and to enable action. To use the outcomes for marketing and for product ratings and comparisons is to misuse the study. The Australian wool LCA was conducted to identify the relative environmental impacts associated with production, processing and use of typical products and to inform research directions.

One clear outcome of the study was that biogenic methane is the major contributor to the 'carbon footprint' of wool and the Australian livestock industries (with other countries) are seeking to develop means to reduce enteric emissions. In fact direct emissions of enteric methane from livestock internationally are estimated by IPCC to contribute as low as 4% of global $CO_2$-e emissions (an earlier report by the UN FAO that calculated 18% from livestock has been shown to contain errors [11,12]).

Water and energy use in garment manufacture occurs mainly in the dyeing and finishing stages, however the quantities are much lower than used in garment care, especially in climates where hot water washing and electrical drying are used in domestic laundry of garments. Retailers and energy authorities are beginning to argue for garment washing to be conducted at lower temperatures and for air drying to be used more extensively, however this is difficult in many climates and in high density living. Water and energy use in textile processing is still significant and there are few mills where savings cannot be made.

LCA studies have shown that significant resource savings can be made by recycling of textiles as compared with manufacturing of new garments. There is growing awareness that large tonnages of textile goods are sent to landfill in developed countries. This is an area of increasing concern and legislation has been signalled in Europe to encourage greater recovery of used textile goods. Some commentators see the decline of cheap, disposable fashion and a return to durable, high quality garments. This trend can only benefit the wool industry.

## 3 Conclusions

The choice of an eco-label will increase the ability of wool processing industries to meet the expectations demanded by western markets for sustainable and environmentally friendly textile products. Australian wool is well placed to take advantage of this emerging global trend.

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