REUSABLE BAGS FOR A REUSABLE ENVIRONMENT

Taking the Confusion Out of Environmentally Friendly Bag Options

ALBURY ENVIRO BAGS

Introduction

Based upon an extensive review of the available evidence, this article seeks to assist consumers in choosing the reusable shopping bag fabric which best suits their needs. It is an attempt to cut through the confusion of the public shopping bag debate by enabling the consumer to form an evidence-based evaluation of the various reusable bag options. Due to the environmental costs of single use throw away bags, these bags were not considered in this article.

In considering the pros and cons of the various options it is not possible to supply a definitive answer as to which fabric is the 'best' or even whether one fabric is better than another in ALL applications. One vitally important general principal does emerge however, and that is the issue of durability and useful life span. Environmental advantages are strongly linked to the useful life span of the bag and therefore are heavily dependent upon consumers looking after their bags and reusing them for as long as possible. A quality reusable natural fibre bag may be worse for the environment than a single use bag if it is disposed of after being used for only 20% of its useful life. This fact heavily influences the evaluation of the various fabrics below.

Another reason why definitive answers cannot be provided is because there are so many unknowns, one of these relating to the accumulation of microplastics in the environment. All plastic bags which find their way into the eco system eventually degrade into tiny pieces of plastic, perhaps invisible to the naked eye, and these are accumulating in the environment. The long-term consequences of this accumulation are simply unknown.

New technology is also changing bag disposal options. For instance, one of the major criticisms of certified compostable corn starch bags in the media relates to their specified rate of compostability only being achievable in industrial composting facilities which are few and far between. Disposal by other means, it is claimed, results in adverse environmental consequences. However, around Australia Councils are introducing what is referred to as the FOGO (Food Organics and Green Organics) green bin collection service. Certified compostable corn starch bags may be disposed of through these green bins, which, unlike the old green bins for garden waste only, are now diverted to industrial composting facilities.

In considering the available fabric options, to many consumers budget is the bottom line. I have therefore arranged the common options below in order of typical cost, most economical being first.

1. **Non-woven polypropylene**
2. **Certified compostable non-woven corn starch**
3. **RPET**
4. **Cotton/calico**
5. **Light weight hemp**
6. **Jute**
7. **Cotton Canvas**
8. **Hemp canvas**

For the reasons outlined above, I can only seek to inform the reader of the available evidence, and issue general guidelines, the final decision regarding the suitability of a fabric in a particular application is up to the consumer. Given these facts, I have summarised some of the pros and cons in the table below.

I hope the reader finds this information useful in cutting through the confusion generated by the public debate.

Graham Williamson
October 2018

COMPARISON OF COMMON REUSABLE SHOPPING BAG FABRICS

	Fabric	Comments
Better environmental options*	**Hemp**	Its rapid growth, high output per acre, minimal need for agricultural chemicals, & its high strength, make this one of the most environmentally attractive and sustainable natural fibres. On the downside is the relatively high cost and the fact that chemical processing of fibre is often used. If mechanically processed or organic hemp can be obtained, this is ideal. Hemp canvas is very expensive but very durable.
	Jute	Jute is one of the most popular options and compares with hemp in many ways, though not so expensive. On the downside, most consumers prefer a rigid jute shopping bag which is lined with plastic. The alternative is either unlined jute or jute which has been stiffened with starch. Another downside for jute is that most jute is processed using mineral oil. As an environmental option jute should be unlined and hydrocarbon free.
	Certified compostable reusable non-woven corn starch	Compostable corn starch has many environmental advantages, especially in the reusable non-woven form which is capable of carrying more than 18kg and can be reused many times. This makes it very competitive with other reusable bags such as jute and non-woven polypropylene. One common criticism relates to claims it will only compost effectively in industrial composting facilities. However, with the introduction of the FOGO municipal bin system, 100% compostable bags may be disposed of through the residential green bins. Consumers should check with their local authorities. Other claims of ingestion by wild life relate to the thinner single use bags, not the reusable non-woven corn starch bag.
	Cotton canvas	Although cotton has attracted adverse publicity because of its high water and chemical consumption, canvas is recommended ahead of cotton because of its strength and durability. It is one of the more durable fabrics, especially in the heavier grades.
	Cotton/calico	As noted above, cotton has fallen out of favour with many because of its high water consumption and its high need for agricultural chemicals.
Less attractive environmental options*	**Non-woven polypropylene & RPET**	Non-woven polypropylene & RPET both have their advantages, however, because they both have the potential to add to the accumulation of microplastics in the environment better options are available. The low cost of non-woven polypropylene will no doubt continue to make this fabric the number one choice for many however.

***Note:** This classification is not definitive and reflects the opinion of the author. Canvas receives a higher rating because of its durability and potential for extended use. Non-woven PP and RPET are downgraded because of the unknown consequences of possible environmental microplastic accumulation. Additionally, certain fabrics may have more durability and better suit specific applications. These issues are up to consumers to decide.

Pollution, Pollution, & More Pollution

These days, listening to the media, people are encouraged to think that they are either saving the world or destroying the world according to what type of shopping bag they use. Of course, this type of ill-informed debate, often encouraged by those pushing their own barrow, could not be further from the truth. Shoppers, or more specifically, shopping bags, are not the main causes of pollution on the planet. Industries, from automotive, to white goods, to electronics such as computers and mobile phones, are all responsible for a colossal amount of pollution. Not to mention the petroleum industry.

When it comes to plastics, we are all familiar with the endless plastic packaging used everywhere, including many products buried deeply within 2 or 3 layers of plastics. Even milk bottles now are frequently made from plastic whereas previously, when there was not so much concern about the environment, milk was supplied in glass bottles which were cleaned and recycled. The same is true of soft drinks, which were once supplied in recyclable glass bottles. Perhaps one of the most wasteful practices of all is the use of temporary hamburger or meal containers by fast food chains. These containers, whether made from polystyrene or cardboard, are manufactured for a useful life cycle of perhaps 5-10 minutes while the customer removes the food and consumes it. This practice has been driven by large multinationals, replacing the previous practice of using washable containers for eat in, or wrapping food in yesterday's newspaper for take away.

And, after purchasing nearly everything wrapped in plastic, then we throw it all in a plastic bin liner and dispose of it in the red bin, to go to landfill.

To a very large degree, this is the nature of the waste management system that has been designed for us. The public did not design garbage bins, bin liners or the municipal waste system. And neither did the public design throw away food containers or endless layers of plastic packaging.

While there seems to be little concern about many of these issues there are certainly many people suddenly objecting strenuously to the use of plastic shopping bags. The first message of this article is to adopt a balanced evidence-based perspective.

The bottom line is, this article is about bags, and we are seeking to answer the following questions:

- What is the best way of minimising environmental contamination caused by shopping bags?
- How can we adopt a constructive evidence-based approach to tackling this problem?

The first step in answering these questions is to acknowledge the fact that single use throw-away bags are not the answer. Producing millions of bags (more than 7 billion annually) to be thrown away daily has been a big part of the problem. Only by using a suitable reusable bag can we break this massive resource wastage and pollution resulting from this daily production-disposal cycle. However, in order for the environmental advantages of reusable bags to be fully realised, research suggests that such bags may need to be reused 50- 100 times (1, 2, 3, 4). It is clearly up to shoppers to maximise the life span of their bags, regardless of which type of bag is used.

While this article seeks to uncover the relative pros and cons of the various bag fabrics, according to the cited evidence, it should be realised firstly, that ALL bags have an environmental cost, and secondly, in many ways the jury is still out and definitive answers are simply not available. It is up to the reader to evaluate the evidence. It is also up to the reader to decide the most suitable bag, and most durable bag, in his/her particular application

The options below will only include bags that are reusable, and have a useful life span, given normal use.

Environmental Attributes of Shopping Bag Fabrics

1. The Two Most Popular Reusable Shopping Bag Options – Jute & Non-woven Polypropylene

Jute Bags (5, 6, 7, 8, 9, 10, 11, 12)

Jute fibre is a natural biodegradable and compostable fibre obtained from the jute plant (Corchorus olitorius and Corchorus capsularis). Jute is a rainfed crop which is cultivated mainly in Bangladesh, India and Thailand which account for more than 90 percent of world production. Jute is very fast growing reaching a height of up to 4.5 meters in a period of 5 months. Jute fibre is a long, soft, shiny fibre that can be spun into coarse, strong threads. Jute is a renewable energy source with a high production per hectare.

Jute fibre is used to produce hessian cloth, bags, carpet backing and geo-textiles. Jute cultivation and processing is labour-intensive and therefore provides a livelihood for many farmers and their families. Jute plants also clean the air by consuming large quantities of greenhouse causing CO2. One hectare of jute plants can consume about 15 tons of CO2 and release about 11 tons of oxygen during the jute growing season.

Some of the advantages of jute are listed below:

- One hectare of jute plants can consume about 15 tons of CO2 and release about 11 tons of oxygen during the jute growing season.
- Globally jute is the second most important vegetable fibre after cotton in regard to terms of usage, production, and availability.
- Jute fibre has high tensile strength, low extensibility, and ensures better breathability compared to synthetics.
- Jute produces top quality yarn, fabric, and sacks. It is one of the most versatile natural fibres used for packaging, textiles, and agricultural sectors.
- Jute is a renewable resource with a high production per hectare.
- Jute has the ability to be blended with other fibres, both synthetic and natural, and accepts various dyes such as natural, basic, vat, sulphur, reactive, and pigment dyes. As the demand for natural fibres increase, the demand for jute and other natural fibres that can be blended with cotton will increase. Combined jute/cotton blends may produce fabrics with a reduced cost of wet processing treatments. Jute can also be blended with wool.
- The growing of jute provides an income for more than 4 million farming families in poor communities.

Jute farming is a very labour intensive process, comprising 60%-70% of total production costs, which produces very low monetary rewards on a per hectare or per ton basis. It has been estimated that 215 man-days of labour are required per ton of fibre with the result that the farmer often earns less than US$0.70 per day for his labour. Notwithstanding these facts around 2-3 million tons of jute are produced every year principally in the main jute producing countries, India and Bangladesh. In spite of the low monetary returns, jute farming supports 4 million farmers and their families in India alone and these farming families are located in some of the poorer areas of India. Jute farmers usually rotate their jute crop with rice. Since they are situated in very high rainfall areas these farmers have limited crop choices and jute is a crop of choice in such locations.

Disadvantages of Jute

Apart from cost, jute fabric has the disadvantage that it is treated with toxic mineral oil, referred to as 'jute batching oil' during the production process (24, 25, 26, 27, 28, 29, 30). Although an alternative vegetable oil such as rice bran oil, or 'hydrocarbon free' oil, is available (31, 32, 33), hydrocarbon free jute is more expensive and is commonly reserved for food grade jute products (34, 35, 36, 37).

A second major disadvantage with jute is due to the fact that jute bags are commonly supplied laminated with an interior lining of plastic. This plastic lining gives the bag rigidity and increased durability, but of course, it also renders the

bag (or the plastic component of the bag) non-biodegradable. This plastic lining can constitute 10% - 15% of the total bag weight. Unlined jute bags are commonly available, but are not so popular with consumers. Another option is to stiffen the fabric with starch, however this is not durable and is very susceptible to moisture.

Non-woven Polypropylene Bags (1, 2, 3, 4, 13, 14, 15)

These bags have long been favoured by major supermarkets and environmental organisations because of their low cost and long life span. Non-woven polypropylene bags create less litter and use significantly less material resources and energy resources than paper bags, cotton bags, or single use plastic bags and do not require the huge water resources and agricultural chemicals required by cotton. On the downside, non-woven plastic polypropylene bags are manufactured from polypropylene gas, a by-product of oil refining and are therefore made from non-renewable resources.

Microplastics & eco-toxicity

Non-woven polypropylene is not biodegradable or compostable and may take many years to break down in the environment and this is a matter of increasing concern for all plastics. Plastics, such as non-woven polypropylene, degrade in the environment into smaller and smaller pieces of plastic called microplastics (19). Microplastics are so tiny they are not visible to the naked eye and they therefore represent an irretrievable accumulation of plastic in the eco system. Further, microplastics have been found in tap water, in beer, in bodily fluids, and in the air (19, 20, 21), even though the science of microplastics is only new and much remains to be learned. Presently, we know (19)*"we are all drinking, eating and breathing microplastic every day",* but we have yet to learn the consequences of this.

It is for these reasons that some communities are banning the use of non-woven polypropylene bags (17, 18).

Notwithstanding these facts however, non-woven polypropylene bags are often considered to have a relatively low environmental impact, because of their long life and reusability, and the fact that they degrade into smaller pieces of plastic more quickly than many other types of plastics. According to **Sustainability Victoria**, "*The reusable, non-woven plastic (polypropylene) "Green Bag' was found to achieve the greatest environmental benefits.*" As CSIRO research scientist, Dr Mike O'Shea points out, the main environmental advantage of the non-woven polypropylene 'green bag', is its reusability:

"the green bag's only environmental credential is that it is not the single-use high-density polyethylene plastic bag still given out in most shops and supermarkets."

Jute vs Non-Woven Polypropylene (5, 6, 7, 8, 9, 10, 11, 12, 22, 23)

Often the choice between these two fabrics depends upon budget, jute bags typically costing around 2-3 times more than non-woven bags when the higher freight costs are also included. Jute's competitiveness with polypropylene, from which non-woven green supermarket bags are manufactured, is related primarily to the environmental footprint of each product. Jute is a natural plant fibre which contributes to the livelihood of many farmers in developing countries whereas polypropylene is a totally synthetic non-compostable plastic manufactured by the petrochemical industry.

Both bags have been endorsed by various organisations. **Burwood Council**, **Ipswich City Council**, and Clean Up Australia have endorsed jute bags. According to the **United Nations** in their report entitled **Jute and Hard Fibres: Overview of Major Current Issues**, jute has the following advantages as compared to non-woven polypropylene.

- **Production of polypropylene fibre requires 10 to 20 times more energy than jute fibre.**
- **Production of 1 ton of polypropylene produces 3.7-7.5 tons of CO2 whereas jute production has a negative impact on CO2 production.**
- **Jute is a totally renewable resource whereas polypropylene is derived from non-renewable resources.**

- **Jute fibre is biodegradable whereas polypropylene is not biodegradable and causes environmental accumulation of plastic and releases cancer causing compounds.**

The environmental advantages of jute are however negated by the use of mineral oil during the processing of jute fibre, and the fact that most consumers prefer jute which is lined with plastic. Plastic free or unlined jute has the vitally important advantage that it does not contribute to accumulation of microplastics in the environment, unlike non-woven polypropylene.

2. Reusable Compostable Non-Woven Corn Starch Bag (38, 39, 40, 41, 42, 43, 44, 45, 46, 47)

In the media, adverse publicity pertaining to 'corn starch bags' is normally confined to single use 'throw away' bags, even if this is not clearly stated. Since such bags do nothing to alleviate the enormous consumption problem, like other single use bags, they have attracted adverse publicity. However, the only corn starch bag to be considered here will be the reusable non-woven corn starch bag.

The 100% reusable non-woven corn starch bag, like its throw away single use cousin, complies with the Australian standard for compostability, Australian standard AS 4736-2006. According to the Australasian Bioplastics Association:

"If a plastic material claims to be biodegradable and compostable in Australia, it must comply with Australian standard AS 4736-2006. This standard provides assessment criteria for plastic materials that are to be biodegraded in municipal and industrial aerobic composting facilities. This Australian standard is similar to the widely known European EN 13432 standard, but has an additional requirement of a worm test. In order to comply with the AS 4736-2006, plastic materials need to meet the following requirements:

- *minimum of 90% biodegradation of plastic materials within 180 days in compost*
- *minimum of 90% of plastic materials should disintegrate into less than 2mm pieces in compost within 12 weeks*
- *no toxic effect of the resulting compost on plants and earthworms.*
- *hazardous substances such as heavy metals should not be present above the maximum allowed levels*
- *plastic materials should contain more than 50% organic materials"*

Around Australia, single use thin (less than 35 microns thick) plastic shopping bags are being banned. In Tasmania, South Australia, Northern Territory, and the ACT, single use thin corn starch bags have been specifically excluded from this ban. In Victoria and NSW, state wide bans have yet to be introduced. In Queensland and Western Australia the plastic shopping bag ban also **includes single use corn starch bags**, however, **the reusable non-woven corn starch bag supplied by Albury Enviro Bags is not included in any of these state wide bans**. Remarkably, the reusable non-woven corn starch bag, under test conditions, has been found to be capable of carrying 19kg on hundreds of 2 hour shopping trips, thereby making it very competitive with other types of reusable bags.

It is important to note that the Queensland government's ban on single use plastic bags (including single use corn starch) is primarily intended to change consumer behaviour by encouraging the use of reusable bags. According to the Queensland government:

"The goal of the ban is to move consumers away from single-use bags and into re-usable bags, and this is the intent of the Queensland Government's consumer education campaign. Though the law only bans plastic bags under 35 microns, retailers should consider how plastic bags that look or feel similar to banned bags will be perceived by the consumer. If retailers do choose to continue supplying plastic bags, and wish to avoid consumer or government criticism, we would recommend choosing bags that:

- *are well above the prescribed regulation thickness*

- *are clearly designed to be reusable*
- *are different in design to the typical singlet bag, and*
- *cannot be mistaken for a banned bag."*

PLA (Polylactic acid) or corn starch plastic, from which certified compostable non-woven corn starch bags are manufactured, has various well known advantages (48, 49, 50, 51):

- Comes from corn, which is a renewable resource
- Does not contain toxins
- Lower greenhouse gas emissions than conventional plastic production (a reduction of 68 percent)
- Corn starch plastic can be composted in facilities for industrial composting
- 65 percent less energy is needed to produce corn-based plastic than to produce conventional plastic
- PLA plastic is competitive with conventional plastic in terms of cost, since petroleum prices are only going up
- Does not contribute to microplastic accumulation in the environment as other types of plastic do.

According to ***Because We Care***:

"Because our bioplastics are made with organic plant materials, they break down within 45 days in a compost environment – about the same time as a dry leaf – offering the most practical and eco-friendly solution existing today. At because we care™, even our most resistant bioplastic products take a maximum of 90 days to decompose completely in the right environmental conditions. These bioplastics need moisture, microbes and soil before they start to break down."

These advantages are further enhanced when the durability and long life of reusable non-woven corn starch bags is taken into consideration.

Disadvantages of Corn Starch Bags

Perhaps the most common criticism of corn starch bags relates to the fact that the claims made for compostability depend upon disposal in industrial composting facilities (38, 42, 43, 44, 45, 46, 47, 52, 53) of which there are only 150 in Australia and 26 in NSW. It is only in these industrial composting facilities, where composting conditions are tightly controlled, that compostable corn starch bags can be composted according to the Australian Standard. **However, this criticism is misleading and invalid since consumers may dispose of 100% certified compostable corn starch bags through their own FOGO green garbage bins where these are available.** The FOGO or 'Food Organics and Green Organics' collection service is being rolled out by Councils in NSW, and around Australia. Waste from the FOGO system is diverted to suitable industrial composting or 'organics composting' facilities. The Australian government has issued a detailed 'Collection Manual' explaining the scheme. Consumers are however, probably best advised to check with their local authorities regarding correct disposal.

Concerns have been raised about the eco-toxicity of corn starch bags when disposed of via other routes of disposal.

Consumers may also dispose of corn starch bags through home composting systems or landfill, the remainder contributing to environmental litter in the general litter stream. In this latter instance, the Queensland government has expressed concern corn starch bags are equally as hazardous to wildlife when they are ingested as are other plastic bags. This is clearly a significant concern which is particularly important in a marine environment. Whether this concern applies to reusable corn starch bags is not clear, although **reusable bags generally are not considered such a threat to wildlife** (55).

Disposal through landfill is a problem because the way landfills are constructed, biodegradability is generally considered impossible in the short term. This is due to the nature of landfills, which are "*not designed to break down waste, only to store it*." Landfills are designed as "*low-oxygen environments*" where aerobic decomposition is effectively prevented, and therefore, "*No bag – reusable or conventional plastic bag – will degrade in landfill*." According to Brisbane City Council's Fact Sheet on Waste Decomposition Times:

"In a landfill, where the waste is compacted and buried, there is very little air, moisture or microbes. Under these conditions, rubbish breaks downs very slowly. An archaeological dig of a landfill in America, fifty years after waste was buried, found perfectly-preserved heads of lettuce, 40-year-old hot dogs, and completely legible 50 year old newspapers.[2] These items are all organic and would normally break down in less than 6 months if exposed to all the elements needed for decomposition
When organic waste is buried in landfill, decomposition occurs in anaerobically, that is in an environment free of oxygen. This process creates landfill gas made up of methane and carbon dioxide, which is captured using pipes and either flared off or converted to electricity. This process occurs so slowly that old landfill sites need to be monitored for landfill gas at least thirty years after dumping has stopped."

Clearly, slow decomposition in landfill is NOT a reason for not using compostable corn starch bags. Criticisms based upon slow landfill breakdown are in fact criticisms of consumer behaviour or landfill design, especially given the fact that 100% compostable bags may be disposed of through the residential FOGO green bin system.

The other possible means of disposal is through domestic composting facilities (38, 44, 45, 47, 48, 49, 54). It is clearly not possible to predict decomposition rates in a home composting situation because the conditions may be so variable, however, some general observations should be noted. Firstly, although decomposition times in such facilities may be prolonged compared to the times which are achievable in industrial composting facilities, in general terms conditions would be expected to be much better than in a landfill situation. Certified compostable corn starch bags have the potential to eventually compost completely in-home composting facilities even though the decomposition times may be prolonged and highly variable. It is claimed times of 10-12 weeks are achievable (45), but the bottom line is, certified 100% compostable corn starch bags will eventually decompose completely, unlike other plastic bags which degrade into microplastics (49). According to the Australasian Bioplastics Association in their submission to the Victorian Environment and Planning Committee Inquiry into the Environment Protection Amendment:

"As certified compostable plastics are fully biodegradable, there is no risk of micro plastic being available to the environment when disposed of in the required end of life of composting, whether commercial or home……. In the event that littering does occur, all Australian Standard compostable bags are biodegradable in any environment where microorganisms exist, so they will persist for much less time in the environment."

Especially with the introduction of the FOGO green bin system, certified compostable reusable corn starch bags clearly have many environmental advantages compared to many other types of bags. However, the reusable non-woven compostable corn starch bag compares favourably, not just with single use bags, but it also compares favourably with many reusable bags made from natural fibres such as jute and cotton.

3. Hemp Bags (10, 56, 57, 58, 59, 60, 61, 62, 63)

Hemp fibre, a 'bast fibre' like jute, is derived from the hemp or cannabis plant (*Cannabis sativa* L.), a fast-growing herbaceous plant. The *C. sativa* plant contains tetrahydrocannabinol (THC) which at high concentrations is a psycho-active or mind-altering drug. In 90% of *C. sativa* varieties however, the concentration of THC in leaves and flowering heads is low and considered to be harmless. Only low THC varieties may be legally cultivated for fibre crops, the maximum permitted THC content being 0.35% in Victoria, Western Australia and Tasmania, and 1% in New South Wales and Queensland (56). Industrial hemp has a THC content of between 0.05 and 1%. Marijuana has a THC content of 3% to 20% (60). Global production of hemp has been declining since the 1960s, with China accounting for 36% of this production. In some areas though, where it may be legally cultivated, the hemp industry has been growing at an annual growth rate of 20%.

Advantages of Hemp (10, 57, 61, 62, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73)
Hemp, like jute, is a very fast-growing crop that requires minimal agricultural chemicals, and much less water than is required by cotton crops. Advantages of hemp include the following:

- Environmentally, hemp is a safer crop to grow than cotton. Cotton is a soil-damaging crop and needs a great deal of fertilizers, herbicides and pesticides. Cotton crops in the USA occupy 1% of the country's farmland but use 50% of all pesticides. Hemp also requires less chemicals than jute.
- Hemp needs considerably less water needed than cotton.
- More fibre can be harvested from hemp than cotton, jute or flax using the same amount of land, 1 acre of hemp producing as much as 2-3 acres of cotton.
- Hemp is the number one biomass producer on planet earth: 10 tons per acre in approximately four months
- It's one of the strongest natural fibres, being stronger than jute
- Because it is softer than jute, it does not require the use of oil in production, as jute does
- Industrial hemp is relatively pest and disease resistant; partly due to the fact it grows so fast
- Low lignin levels enable environmentally friendly bleaching without the use of chlorine
- Less stretch, so clothing retains its shape
- Its softness increases with use
- When dyed, it retains colour better than cotton
- Excellent breathability
- High abrasion resistance
- Biodegradability
- Hemp plants detoxify the soil by a process called '**phyto-remediation'**

Compared to other natural fibres such as jute, cotton, and flax, hemp clearly has many advantages. Hemp's advantages begin with its agricultural advantages such as rapid growth, high output per acre, and minimal need for water and chemicals. Processing of hemp to produce fibre can be done mechanically with minimal environmental impact, however most companies are increasingly favouring chemical processing (69, 70, 71, 74, 75). The alternative is the "**Organic** method" using "**refined combing technologies"** and "**biodegradable** softening solutions" (72).

Though it is not as soft and fine as cotton, and it is more expensive than most other natural fibres, hemp is probably the most environmentally sustainable of all the natural fibres. These advantages may be lost to some degree if unsustainable chemical processing is utilised.

4. Other Fabrics – Cotton, Canvas, & RPET

For various reasons, these fabrics are not so environmentally popular for shopping bags. Recycled Polyethylene terephthalate (RPET) has been reported to be environmentally similar to non-woven polypropylene (3, 77) although RPET lacks the strength, rigidity, and durability for large capacity shopping bags. Both of these fabrics may ultimately lead to the accumulation of microplastics in the environment (76).

Much has already been said about cotton, especially the huge amount of water necessary to grow it, and process it. It also consumes vast amounts of agricultural chemicals unless grown organically. Lightweight cotton is also not suitable for high capacity shopping bags, although the heavier grades of canvas do produce very attractive and very durable shopping bags. Canvas shopping bags may not compete environmentally with some of the other options, but they are among the best for attractiveness and durability.