# STUDY-THIN PLASTIC BAGS

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## TYPES OF PLASTICS

Plastic is polymeric material that has the capability of being molded or shaped, usually by the application of heat and pressure. This property of plasticity, often found in combination with other special properties such as low density, low electrical conductivity, transparency, and toughness, allows plastics to be made into a great variety of products.

The word "poly" comes from the Greek word "many," and "mer" means parts. Polymers are made of many long chain-like molecules that are aligned together or twist in various shapes. All polymers are made of small repeating molecules, called monomers. Polymers are long-chain, sheet-like, or even three-dimensional, very large molecules made up of many smaller molecules. How the molecules and chains bond can result in a variety of properties. Polymers can be natural and synthetic. Natural polymers include cellulose, starch, wood and rubber. These are also known as biopolymers.

The other category consists of synthetic or artificial polymers which include the various types of plastics. On the basis of thermal properties, plastics are further divided into-

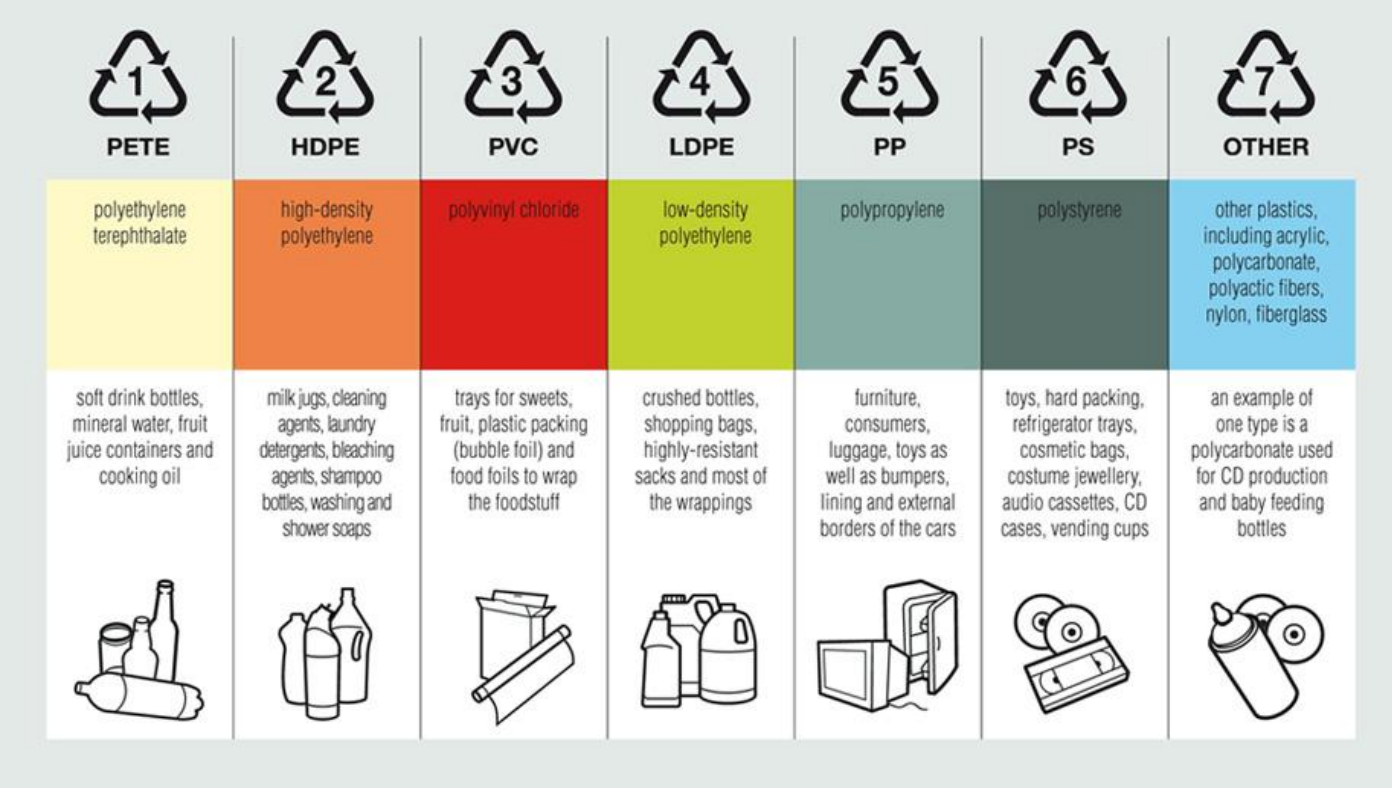
- *Thermoplastics* such as polyethylene and polystyrene are capable of being molded and remolded repeatedly with heat. Thus, a foamed-polystyrene cup can be heated and reshaped into a new form—for instance, a dish (Injection moulded, blow moulded or vacuum formed). The polymer structure associated with thermoplastics is that of individual molecules that are separate from one another and flow past one another. The molecules may have low or extremely high molecular weight, and they may be branched or linear in structure, but the essential feature is that of separability and consequent mobility. Good examples are acrylic, polypropylene, polystyrene, polythene and PVC.

- *Thermosets*, on the other hand, cannot be reprocessed upon reheating. During their initial processing, thermosetting resins undergo a chemical reaction that results in an infusible, insoluble network. Essentially, the entire heated, finished article becomes one large molecule. For example, the epoxy polymer used in making a fibre-reinforced laminate for a golf club undergoes a cross-linking reaction when it is molded at a high temperature. Subsequent application of heat does not soften the material to the point where it can be

reworked and indeed may serve only to break it down.[1] Good examples are melamine (kitchen worktops), Bakelite (black saucepan handles), polyester and epoxy resins.

Thermoplastics are more readily recycled than thermosets. The simplest polymer is polyethylene which we are well acquainted with in the form of the transparent, flexible plastic bag.

In 1988, the Society of the Plastics Industry (SPI) established a classification system to help consumers and recyclers properly recycle and dispose of each different type based on its chemical makeup. Today, manufacturers follow a coding system and place a number, or **SPI code**, on each plastic product, usually molded into the bottom. You should always verify the plastic classification number of each product you use, especially if you plan on recycling it. The following table provides a basic outline of the different plastic types associated with each code number.




**Source:** www.americanchemistry.com

Plastics can also be divided into recyclable and non-recyclable plastics (NRP). Any type of plastic which has no number for recycling comes under the non-recyclable category. This includes trash bags, ziplock bags, bubble wrap, clear plastic wrap, department store bags, potato

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chips bags, plastic packs and candy wrappers. Also, soiled or dirty plastics bags and bottles also fall under the NRP category as they do not qualify for recycling due to their soiled nature.

**Plastic Bags**

Plastic Carry Bags are generally made out of polyethylene (polythene) which is used in contact with food stuffs, pharmaceuticals and drinking water and its use in these critical areas is approved by the regulatory authorities across the world including that in India like Bureau of Indian Standards (BIS)

History

In 1965, Swedish company Celloplast came up with the design on which all modern plastic shopping bags are based: a tube of plastic sealed at the bottom to allow for the packaging of goods, an open top to insert such items into the bag and handles for convenient carrying. This model bag, which later became known as the "T-shirt plastic bag," was made from high-density polyethylene, or No. 2-type plastic – the same used to produce plastic bottles and plastic lumber.

ExxonMobile was responsible for introducing the plastic shopping bag to the U.S. which was popularized in the 1970s by various supermarkets as a grocery bag. This slowly spread to other countries, revolutionizing the way people carry their shopping home.


Interestingly, the grocery plastic bags replaced paper bags that were commonly distributed by supermarkets at that time. The introduction of plastic bags created a huge uproar as people found the material too flimsy to hold their groceries as compared to paper bags which stood upright in their cars. Plastic bags were welcomed by pedestrians who found the t-shirt design convenient to carry while walking home.

Benefits

The attributes, which have made the use of plastics safe and popular as a packaging material in general and as a carry bag in particular, are:

- Non-toxic characteristics, inertness and chemical resistance.
- Excellent barrier properties, air-proof and water-proof characteristics.
- Safe in handling due to non-breakability, Light in weight hence reducing packaging costs and cost of transportation
- Due to the feature of negligible weight and volume, the use of plastics have been attributed to the reduction in the carbon footprint of transportation as more products can be carried in one trip thereby reducing the number of trips needed to transport a certain amount of goods.
- Transparency, allowing easy visibility of content being carried/stored/packed.
- Can also be opaque to hide/protect the content from exposure to sunlight, when required.
- Resistance to bacterial and other microbial growth.
- Pilfer proof characteristics etc.

Chemical Properties

Plastic bags are basically LDPE or low density prolyethylene. Polyethylene is a polyolefin. Polyolefins are high molecular weight hydrocarbons. Polyolefins include linear low density polyethylene, low density polyethylene, high density polyethylene, polypropylene copolymer, polypropylene, and polymethyl pentene. These are the only plastics that have a lower specific gravity than water. This means that they weigh less than water. These materials can become brittle from oxidation and are damaged by exposure to UV light. When ethylene is polymerized the result is relatively straight polymer chains. From the main chain they can branch out. We get different kinds of Polythylenes from the varying degree of branching in their molecular structure.

LDPE has the most excessive branching. This causes the low density to have a less compact molecular structure which is what makes it less dense and flexible. Chemically, LDPE is a carbon-chain polymer.

- It has a density of 0.92-0.93 $g/cm^3$
- It has a moderate degree of crystallinity
- It's crystal melting temperature is 110 $^oC$
- Tensile strength of 8-30 MPa
- Elongation at break is 100-650%
- Flexural modulus is 0.25-0.35 GPa

Degradation

Polythene bags are bio-degradable if its chains have a molecular weight less than 500. But polythene has a higher molecular weight of $10^5$ generally. Hence the plastic would need to be treated to reduce molecular weight before it can biodegrade naturally.

**Know Your Plastic Bags**

*Degradable Plastic Bags:*

The word "degradable" just means that something breaks down. Technically, all plastic is degradable plastic. You can break it with a hammer. You can grind it into a fine powder. This all counts as "breaking down" the plastic, and therefore technically, "degrading" the plastic.

Manufacturers can also add chemicals that will make the plastic break down faster under certain conditions. For example, you can add an additive to normal, petroleum-based plastic that will make it become brittle and crumble in sunlight: this is referred to as making "photodegradable" plastic. Other additives can be put into plastic that will make plastic break down by oxidation: this is referred to as making "oxo-degradable plastic."

These methods will make the bulk of the plastic appear to disappear; however, the small pieces (or even find "sand") that is produced by this effect is still small pieces of plastic. So be cautious when you see a plastic product that advertises that it is "degradable" but not "biodegradable" or "compostable," because this is nothing special. The plastic material does not "return to the earth" in any real way. It just gets really, really small.

*Bio-Degradable Plastic Bags:*

If a plastic bag is claimed to be bio-degradable it means it is capable of being broken down by the metabolism of micro-organisms. When a plastic is biodegradable, it can be digested, so that the carbon atoms in the chains of the polymer are broken apart and can actually participate in the creation of other organic molecules. They can be processed by, and become part of, organic living things. This returns them to nature in a very real sense: they become part of the carbon cycle of the ecology of the earth. This process is said to happen within a reasonable time scale. Research is being done to determine how long it actually takes to return to the earth. The process of bio-degradation cannot take place in landfill like conditions where they are away from sunlight, air and water. Polythene is biodegradable as long as its chains have a molecular weight of less than 500.

*Oxo-Biodegradable Plastic Bags:*

These bags are made of plastic which is conventional polyolefin plastic to which has been added small amounts of metal salts, none of which are "heavy metals" which are restricted by the EU Packaging Waste Directive. These salts catalyze the degradation process to speed it up so that the OXO plastic will biodegrade abiotically at the end of its useful life in the presence of oxygen much more quickly than ordinary plastic. OXO-biodegradable products utilize a pro-degradant to speed up the molecular breakdown of the polyolefins and to incorporate oxygen atoms into the

resulting low molecular mass molecules to less than 500. This chemical change enables the further breakdown of the material by naturally-occurring micro-organisms.

The useful life of a product made using oxo-biodegradable plastic can be programmed at manufacture, typically 6 months for a bread wrapper and 18 months for a lighweight, plastic carrier bag to allow for re-use. Oxo-biodegradable plastic can be manufactured with the existing machinery and workforce in factories at little or no extra cost. They have the same strength and other characteristics as ordinary plastics during their intended lifetime.

*Compostable Plastic Bags:*

They are bags made of vegetable based plastics that undergoes degradation by biological processes during composting to yield CO2, water, inorganic compounds and biomass at a rate consistent with other known compostable materials, excluding conventional petro-based plastics, and does not leave visible, distinguishable or toxic residue. They are said to emit methane if sent to landfills and hence are supposed to be composted, not dumped. These are the category of plastic bags claimed to be 'bio-degradable plastic bags.' But all bio-degradable plastics are not necessary compostable. The standard definition to clarify this is that if a biodegradable plastic will completely biodegrade fast enough in a certain type of environment, then it can be labelled "compostable." Hence compostable plastics are just a subset of bio-degradable plastics.

*Photo Degradable Bags:*

Photodegradable plastic is usually made of oil-based polymers, just like ordinary plastic. It either has bonds in its structure that can be weakened and broken by sunlight, or it contains a chemical additive which absorbs light and then attacks the polymer and breaks some of the bonds. Once a photodegradable plastic is exposed to light it begins to break down – whether you want it to or not. This can be disastrous if it is mixed in with other plastics during recycling. Photodegradable plastics tend to break down into small particles of plastic rather than decomposing completely. The idea is that these small pieces will then biodegrade. Unfortunately, they are often not biodegradable and so remain in the environment. The effect that a build-up of small pieces of plastic in the soil might have on the environment has not been investigated.

At present, most plastic waste ends up in a landfill site where it is buried in a dark hole in the ground. Under these conditions, photo degradation cannot take place.

**Why not plastic below 40 micron?**

- Plastic of low thickness is difficult and useless to collect and store separately. Thicker plastic bags are easier to recycle and give rag-pickers an incentive to collect them. Since a few hundred carry-bags are required to make a kilo of saleable scrap, it is simply not economical for waste-pickers to collect such ultra-thin waste, even if it is 20 micron or more, so it remains in the garbage in increasing quantities.

- Storage itself is an uneconomic activity because of the fact that plastic bags are given away for free at retail stores and have no value.
- Secondly plastic also gets used for garbage collection and packaging. This is extremely unhealthy as plastic is not biodegradable while the garbage contents are and this ultimately leads to the rotting of garbage inside the bag, developing pathogens and preventing the scientific disposal of waste.
- Lightweight plastic also flies around and gets stuck in trees, interfering with their photosynthetic process.
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It also comes in contact with birds, marine life in water bodies and in cattle feed and is severely hazardous as animals either mistake it for food or end up getting strangled by it.
- Plastic bags have also been blamed for choking drains and causing the horrific floods in Bangladesh and Mumbai which killed several people and subsequently led the places to ban the use of these bags.
- Plastic bags are made of oil and oil is a precious resource, too precious to be use in a one-time use product. Estimates say that one plastic bag uses enough oil to run a car 11 metres.
- Thin plastic bags take atleast 10-20 years to degrade. 10 years if they are exposed to the open air and sunlight, while 20 years or more if they are buried deep in a landfill.
- Plastics bags are not biodegradable, they are photo degradable. So thinner the bag, more easily will it get broken down by sunlight into small pieces that continue to persist in the soil and end up in water and animal bodies.
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**Polluting the Oceans**

Plastic is the biggest polluter of oceans and water bodies because it can float on and inside the water for years at a stretch. Evidence of how alarming this problem has become can be found on the 7500 km Indian coast where plastic invariably makes up a large part of the catch that fishermen haul in their nets along with other sea organisms. A study conducted by some US based research organisations revealed that India is one of the top 20 coastal populations that

pollute the oceans with plastic debris. A study in the journal PLOS estimated that a minimum of 5.25 trillion floating plastic particles weighing 268,940 tons are in the ocean. This estimate included only surface plastics, and not the materials that have sunk. It is commonly known that there is an island of garbage in the Pacific Ocean called The Great Pacific Garbage Patch. Such a patch in known to exist in every ocean now. Garbage floating on ocean water has also been said to impede search and rescue missions for the recent debacle of the lost Malaysian airplane.

Overtime, these plastic bits get degraded by the sun and the waves to disintegrate into smaller and smaller fragments still continue to remain in the water for several hundreds of years. These also become food for unsuspecting marine animals who unknowingly ingest these particles. The problem doesn't end here since after they die their body is decomposed by the ocean itself and that plastic they ingested enters back into the water. These fragments are now known as micro fibres that embed themselves on organisms and the ocean floor. A study conducted by a marine biologist, Richard Thompson revealed that every square kilometer of deep ocean contains about four billion plastic fibers—most are two to three centimeters in length and as thin as a human hair. The fibers are four times more abundant in the deep sea than in surface and coastal waters.

Solutions for India

- Streamline a recycling system which offers an incentive to fisherman to save the trash that gets stuck in their nets instead of throwing it back into the sea. This would not only supplement their income but also remove plastic debris from the oceans which can prove very harmful to marine life and subsequently humans who are in that food chain.
- An island landfill. Like the Semakau island created by Singapore and Cuff parade in Mumbai. The benefits and detriments of this need to be further researched in an Indian context.

**Laws on Plastic Bags**

Plastic Waste (Management and Handling) Rules, 2011 bans storing, carrying, dispensing or packaging of foodstuffs in carry bags made of recycled plastics or compostable plastics. They had several provisions with regards to packaging, labelling, pricing, manufacturing etc. It replaces the Recycled Plastics Manufacture and Usage Rules, 1999. Under the new rules, carry bags made of recycled and compostable plastics should conform to the guidelines laid down by the Bureau of Indian Standards. Carry bags should be of a minimum 40 microns of thickness. They should either be white or made using pigments and colorants which are in conformity with Bureau of Indian Standards. These pigments and colorants are primarily meant for use in plastics that are in contact with food stuffs, pharmaceuticals and drinking water.

The new draft of the Plastic Waste Management Rules, 2015, has initiated the inclusion of several stakeholders in an attempt for effective plastic waste management. The draft rules have tried to broaden the scope of the existing Plastic (waste management and handling) Rules, 2011 by including more stakeholders, redefining some definitions and making some other significant changes such as changing the minimum thickness of plastic bags.

Every urban local body shall be responsible for development and setting up of infrastructure for segregation, collection, storage, transportation, processing and disposal of the plastic waste either on its own or by engaging agencies or producers. This should be carried out while ensuring that minimum damage to the environment takes place during the process.

Thickness

The minimum thickness of plastic materials has been increased to 50 microns. This include carry bags(virgin and recycled) as well as packaging films and covers. This does not include plastic used in multi-layered packaging. This is done with the belief that plastic bags of a higher thickness are costlier to both produce and purchase and should eventually reduce their use.

Phase Out

Producers are required to phase out the manufacture of multilayered packaging and replace it with recyclable and compostable plastic for packaging non-food commodities in the next three years. The use of plastic packets and sachets has also been banned for commodities like *gutka, paan* and tobacco.

Disposal

Wet bio–degradable waste, dry recyclable and combustible wastes and domestic hazardous wastes shall be segregated at source. Segregation is the responsibility of the waste generator. The recyclable plastic should then be sent to a registered plastic waste recycler.

Recycling

Urban local bodies shall encourage the reuse and recycle of plastic waste by adopting suitable technology such as road construction, for energy recovery, etc. in compliance with the standards and pollution control norms specified by the prescribed authority in this regard. Recyclers will

not be granted registration unless their unit possesses a valid consent under the Water Act, 1974 and the Air Act, 1981.

Labelling

Production and use of labelled plastics is mandatory. All carry bags and packaging should have the name, registration number and thickness printed on it. They must also have the 'recycled' label with SPI code in accordance to IS 14534. Retailers are responsible for ensuring the plastics they deal with fulfill these requirements, otherwise, they are liable to be fined.

Pricing

The Rules have made it compulsory for plastic bags above 50 microns thickness to be charged at the retail point of distribution. The purpose of a price imposition is to make bags costly so as to induce the consumer to switch to other alternatives such as cloth bags or the reuse of old plastic bags. No standard fee on plastic bags has been decided yet. The cost will be determined by the urban local body (ULB) depending on the quality and cost incurred to make the bag. This fee will be used by the ULB to utilize for sustainable waste management.

Composting

Compostable plastics must not be used for storing, carrying or packaging food stuffs and medicines.

Manufacture

Producers are required to follow the Extended Producer's Responsibility (EPR) to establish a waste collection system either individually or through the Urban Local Body (ULB). Extended Producer's Responsibility (EPR) means the responsibility of a producer for the environmentally sound management of the product until the end of its life. They are also required to keep a record of their suppliers of carry bags or packaging material.

Registration of Manufacturers.

No producer can engage in using plastic or multilayered plastic packaging of commodity without registration under the State Pollution Control Board within one year of publication of these rules.

**Implementation in Pune City**

Pune is among the top ten waste producing cities in the country. As of 2014, the city has been generating over 225 metric tonnes of plastic waste every day. It is believed by the solid waste management department that cities where the service sector is thriving have a particularly high rate of plastic waste generation. Though the PMC passed a resolution to ban plastic bags in the city, there is no certainty about the rule since the resolution has been challenged by plastic manufacturers in High Court, whose decision is pending. Similarly the rule related to the banning of bags under 50 microns is only enforced when the civic body is conducting drives. After the drives the use of these bags rises once more. Most stores charge for thick plastic bags and

segregation of garbage is encouraged but these measures are not widespread and will not be a success unless citizens do their bit.

**Reuse of Plastic bags to reduce Waste**

1. Plastic Sand

   Plastic can be melted till a particular temperature and blended with a mixture of bitumen, sand and fly ash to make plastic sand which can be used to make roads in place of tar. These roads last longer than tar roads. This could aid in the setting up of a medium scale industry and employ dozens of workers and help streamline the collection of thin plastic waste which currently has no value.

   The Rural Development and Panchayat Raj Department had taken up the initiative of laying Bitumen Tar Road mixed with plastic wastes since the year 2003 and completed the works successfully over a length of 1031 Km of roads. Seeing the durability of the road, led to a further sanction of funds to lay more roads made of plastic sand. Since 2011, the Tamil Nadu government has laid more than 2,000 km of plastic rural roads using Vasudevan's technology.

   Plastic sand can also be used to level floor tiles in construction of new houses. Hence it can be used as an effective substitute of sand.

2.  Woven mats and blankets can be made from 'plarn', which is actually plastic yarn obtained from plastic bags. Plastic bags are cut into strips and then sewn or fused together to make one long string which can be used as a yarn.
3. As stuffing in pillows and soft toys
4. Reuse your plastic shopping bags as much as possible instead of accepting a new bag from your local store
5. Use plastic bags at home to protect woolens and seasonal clothes from insects and dust by storing them in plastic bags.
6. Or Just collect the plastic bags you have at home and return them to the store to redistribute again

7. Use your iron to fuse plastic bags together to make waterproof place mats or tablemats for your home
8. Fuel from plastic

   Japanese inventor Akinori Ito came up with an award winning invention where he converts plastic to fuel. His invention is actually a non-polluting, fully contained process that heats up the plastic, traps the vapors and channels them through an intricate system of pipes and water chambers. These, in turn, cool the vapors and condense them back into crude oil. This crude oil can be used in generators and even some stoves. An additional refinement step converts the crude oil into gasoline. This is a revolutionary idea with a two pronged effect on the environment. It reduces plastic waste and it generates a sustainable alternative for a depleting resource like oil.

**Alternatives**

The alternatives to plastic bags are paper bags and cloth bags. Each bag has an environmental impact. Consumers opt for reusable bags, assuming that they are being environmental, but the reusable bag must be reused repeatedly if it is to be beneficial to the environment.

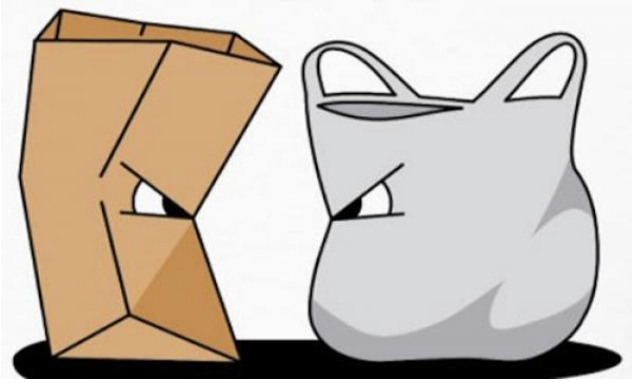
*Paper Bags*

Paper bags are often used by specialty and non-grocery stores, but reuse of the bags is problematic.

A study[2] conducted on the comparison of the environmental impact of paper and plastic bags have the following salient points:

- Paper bag production use and disposal results in 3.3 times the greenhouse gas emissions in comparison to HDPE plastic bags. A Composite Environment Impact Index[3] calculated for both materials, paper and plastic, tracing every step of production, use, and disposal of the bags, found out that paper uses more resources, and pollutes more than plastic. The production of paper consumes much more resources, and produces much more waste than plastic, even if the recycling is taken into account.
- The bags are also anywhere from six to ten times heavier than lightweight plastic bags. Their heavier weight adds costs to municipal waste management, transportation distribution costs and greenhouse gas emissions
- Not durable—tears and loses strength when wet, so these bags curtail reusability

[2] http://www.niassembly.gov.uk/globalassets/Documents/RaISe/Publications/2011/Environment/3611.pdf
[3] http://envimpact.org/paperorplastic

- The disposal of ash from paper production also has an impact on eutrophication and fresh water aquatic eco-toxicity.
-  The production of palm oil for use in paper manufacture affects terrestrial eco-toxicity.

*Cloth bags*

Cloth Bags come in a variety of materials. Cloth bags are usually preferred over both plastic and paper bags in terms of environmental impact provided they are reused repeatedly. These are listed as follows:

- Cotton and canvas bags
- Calico bags
- Hemp Bags
- Jute Bags
- Corn Starch Bags

<u>Comparison</u>

1. For cloth bags to match the environmental efficiency of the conventional plastic shopping bag, they have to be reused hundreds of times. Though all these fabric materials are renewable, they are all very resource intensive, especially in terms of water usage, and harder on the environment due to the heavy use of pesticides, energy and fertilizers required to grow, harvest and process the crops.
2. Cloth Bags are much thicker and more expensive. 30,000 cotton bags can be packed into a 20-foot container, but the same container will accommodate 2.5 million plastic carrier-bags.
3. Thirdly, cloth bags are not very hygienic with regards to reusability as they can become an active microbial habitat and a breeding-ground germs.
4. Cloth bags are highly recyclable like other textiles. Recycling them reduces pressure on landfills and virgin resources.

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