THE STATE OF PLASTICS

World Environment Day Outlook
2018

BEAT PLASTIC POLLUTION

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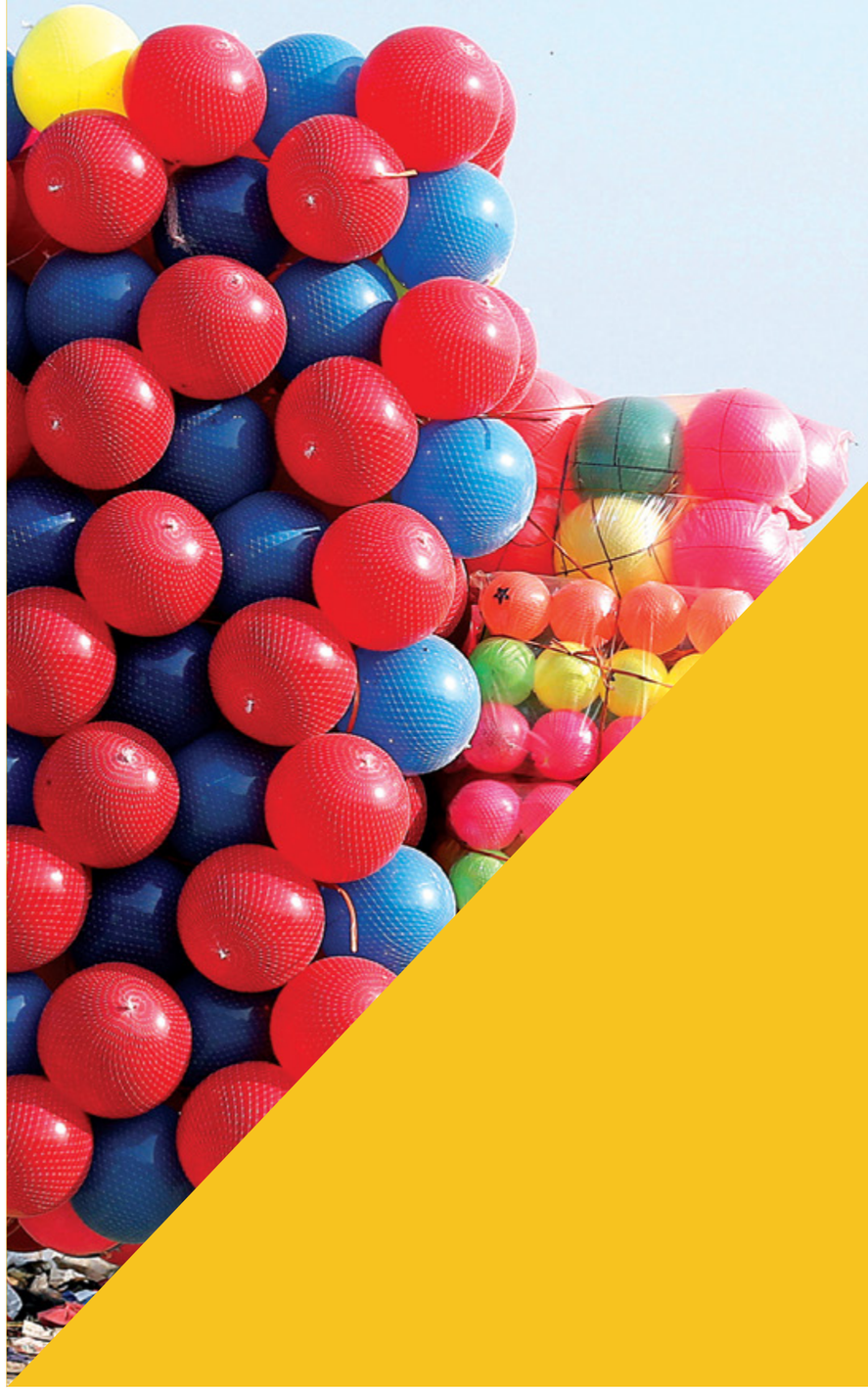
INTRODUCTION



The benefits of plastic are undeniable. The material is cheap, lightweight and easy to make. These qualities have led to a boom in the production of plastic over the past century. This trend will continue as global plastic production skyrockets over the next 10 to 15 years. We are already unable to cope with the amount of plastic waste we generate. Only a tiny fraction is recycled. About 13 million tonnes of plastic leak into our oceans every year, harming biodiversity, economies and, potentially, our own health.

The world urgently needs to rethink the way we manufacture, use and manage plastic. This paper sets out the latest thinking on how we can achieve this. It looks at what governments, businesses and individuals can do to check the runaway production and consumption of plastic. It focuses particular attention on the burgeoning use of unnecessary plastics – the single-use items that make up a large amount of the waste we generate. The paper begins with an overview of the crisis. It goes on to explore the potential of alternative materials and sheds light on the effectiveness of current government legislation to cut down on single-use plastics. Ultimately, tackling one of the biggest environmental scourges of our time will require governments to regulate, businesses to innovate and individuals to act. This paper outlines the possible paths to a world free of plastic pollution.

THE AGE OF PLASTIC: WHY WE NEED TO CHANGE

The scale of the challenge is daunting. Since the 1950s, the production of plastic has outpaced that of almost every other material. Much of the plastic we produce is designed to be thrown away after being used only once. As a result, plastic packaging accounts for about half of the plastic waste in the world. Most of this waste is generated in Asia while America, Japan and the European Union are the world's largest producers of plastic packaging waste per capita. Our ability to cope with plastic waste is already overwhelmed. Only nine per cent of the nine billion tonnes of plastic the world has ever produced has been recycled. Most ends up in landfills, dumps or in the environment. If current consumption patterns and waste management practices continue, then by 2050 there will be around 12 billion tonnes of plastic litter in landfills and the environment. By this time, if the growth in plastic production continues at its current rate, then the plastics industry may account for 20 per cent of the world's total oil consumption.

Most plastics do not biodegrade. Instead, they slowly break down into smaller fragments known as microplastics. When plastic breaks down it becomes even more difficult to remove from the ocean. Studies suggest that plastic bags and containers made of expanded polystyrene foam (commonly referred to as "styrofoam") can take up to thousands of years to decompose, contaminating soil and water. Microplastics, if ingested by fish, can enter our food chain. They have been found in commercial table salt and studies show that 90 per cent of bottled water and 83 per cent of tap water contain plastic particles. Worryingly, little is known about the impacts of microplastics on human health.

The most common single-use plastics found in the environment are, in order of magnitude, cigarette butts, plastic drinking bottles, plastic bottle caps, food wrappers, plastic grocery bags, plastic lids, straws and stirrers, other types of plastic bags, and foam take-away containers. These are the waste products of a throwaway culture that treats plastic as a disposable material rather than a valuable resource to be harnessed.

Plastic waste causes a plethora of problems when it leaks into the environment. Plastic bags can block waterways and exacerbate natural disasters. By clogging sewers and providing breeding grounds for mosquitoes and pests, plastic bags can increase the transmission of vector-borne diseases like malaria. High concentrations of plastic materials, particularly plastic bags, have been found blocking the airways and stomachs of hundreds of species. Plastic bags are often ingested by turtles and dolphins who mistake them for food. There is evidence that the toxic chemicals added during the manufacture of plastic transfer to animal tissue, eventually entering the human food chain. Styrofoam products, which contain carcinogenic chemicals like styrene and benzene, are highly toxic if ingested, damaging the nervous systems, lungs and reproductive organs. The toxins in styrofoam containers can leach into food and drinks. In poor countries, plastic waste is often burned for heat or cooking, exposing people to toxic emissions. Disposing of plastic waste by burning it in open-air pits releases harmful gases like furan and dioxin.

The economic damage caused by plastic waste is vast. Plastic litter in the Asia-Pacific region alone costs its tourism, fishing and shipping industries $1.3 billion per year. In Europe, cleaning plastic waste from coasts and beaches costs about €630 million per year. Studies suggest that the total economic damage to the world's marine ecosystem caused by plastic amounts to at least $13 billion every year. The economic, health and environmental reasons to act are clear.

SECTION 1

GOVERNMENTS

Global plastic production is rising rapidly. By 2030 the world may produce 619 million tonnes of plastic every year. Plastic bag bans, if properly planned and enforced, can effectively counter one of the causes of plastic overuse. But even when they are effectively implemented, such bans are not enough. To reduce the amount of plastic waste we generate, governments must enact strong policies that push for a more circular model of design and production of plastics. Plastic waste must be seen as a resource, not a curse. Governments need to improve waste management systems and introduce financial incentives to change the habits of consumers, retailers and manufacturers. They must pump more money into the research and development of alternative materials, raise awareness among consumers, fund innovation, ensure plastic products are properly labelled and carefully weigh possible solutions to the current crisis. Governments must engage a broad range of stakeholders in the decision-making process as they seek to tackle the crisis. To meet the rising tide of plastics, we urgently need strong government leadership and intervention.

The response so far – a mixed bag

Governments around the world are increasingly awake to the scale of the crisis. More than 60 countries have introduced policies to curb plastic pollution. Plastic bags and, to a certain extent, foamed plastic products like styrofoam have been the main focus of government action so far. This is understandable. These plastic products are often the most visible forms of plastic pollution. It is estimated that roughly 5 trillion plastic bags are consumed worldwide each year. That is almost 10 million plastic bags per minute. If tied together, plastic bags could be wrapped around the world seven times every hour.

The following looks at the various strategies that governments have adopted to date. These fit into four broad categories: levies on consumers, voluntary agreements with retailers, total bans, and a combined ban and levy. The results have been mixed.

Levies on plastic bags. In countries like Ireland where data exist, a dramatic decrease in the use of plastic bags has been recorded when customers are forced to pay for bags. Money raised from the levy can be paid into a fund devoted to combatting plastic pollution and other environmental problems.

Voluntary agreements. In Austria, for example, large retailers agreed to stop providing customers with free plastic shopping bags. Some retailers that have entered into similar agreements with governments have gone a step further, allowing consumers to buy only reusable bags.

Total bans. The Government of Rwanda, for example, has banned the manufacture, use, sale and importation of all plastic bags. Paper bags have replaced plastic ones and citizens have been encouraged to use reusable bags made of cotton. Tax incentives were provided to companies willing to invest in plastic recycling equipment or in the manufacture of environmentally friendly bags. Kenya, which has introduced a similar ban, and Rwanda both punish offenders with jail time or fines. New York City has banned styrofoam products, arguing that it is impossible to recycle the material in an economic and environmentally sound way. China has banned plastic tableware.

Combined bans and levies. In South Africa, the government banned plastic bags below a certain thickness and introduced a levy on food retailers selling 24-litre bags. The strategy did little to reduce the consumption of plastic bags, in part because the levy was too low to change consumer behaviour.

It is too early to draw robust conclusions on the environmental impact that these bans and levies have had. In 50 per cent of cases, information about their impact is lacking, partly because some countries have adopted them only recently and partly because monitoring is inadequate. In countries that do have data, about 30 per cent have registered drastic drops in the consumption of plastic bags within the first year. The remaining 20 per cent of countries have reported little to no change.

Of the countries that have reported little to no impact, the main problems appear to be (i) a lack of enforcement and (ii) a lack of affordable alternatives. The latter has led to cases of smuggling and the rise of black markets for plastic bags or to the use of thicker plastic bags that are not covered by the bans. This has increased environmental problems in some cases.

Given the broad range of possible actions to curb single-use plastics and their mixed impact, UN Environment has drawn up a 10-step roadmap for governments to follow should they seek to adopt similar measures or improve on current ones. The roadmap is based on lessons from 60 countries around the world.

1. Target the most problematic single-use plastics and their source. Assess the impact of these plastics on the environment, human health, wildlife and the economy. If adopting a levy, find out how willing consumers are to pay, so the levy is big enough to change behaviour.

2. Work out the best way to tackle the problem given the country's socio-economic standing. It is pointless to introduce a ban if it cannot be enforced, for example.

3. Assess the social and economic costs of the ban. How will the poor be affected? What impact will the preferred course of action have on different sectors and industries?

4. Meet with key stakeholders – retailers, consumers, industry representatives, local government, manufacturers, civil society, environmental groups, tourism associations – to ensure broad buy-in. Evidence-based studies are also necessary to defeat opposition from the plastics industry.

5. Raise public awareness about the harm caused by single-used plastics. Clearly explain the decision and any punitive measures that will follow.

6. Before the ban or levy comes into force, assess the availability of alternatives. Provide economic incentives to encourage the uptake of alternatives that do not cause more harm. Support can include tax rebates, research and development funds, technology incubation, public-private partnerships, and support to projects that recycle single-use items and turn waste into a resource that can be used again. Reduce or abolish taxes on the import of materials used to make alternatives.

7. Provide incentives to industry. Governments will face resistance from the plastics industry, including importers and distributors of plastic packaging. Give them time to adapt.

8. Use revenues generated by a levy to maximize public good. Support environmental projects and boost recycling with the funds. Create jobs in the plastic recycling sector with seed funding.

9. Enforce the measure effectively.

10. Monitor and adjust the chosen tool if necessary and update the public on progress.

Strategies to phase out other single-use plastics have recently started to appear in several countries. The plastic bag ban in Antigua and Barbuda has led to a ban on the import of plastic food containers and the use of plastic utensils. Costa Rica plans to ban all single-use plastics.

Public-private partnerships and voluntary agreements can be good alternatives to

bans. Voluntary reduction strategies allow citizens time to change their consumption patterns and provide an opportunity for affordable and eco-friendly alternatives to hit the market. The promotion and adoption of reusable bags is an example of a reduction strategy where the choice lies with the consumer. This strategy has changed consumer behaviour and reduced the use of conventional plastic bags in many regions. In Canada, for example, reusable bags have been widely embraced after they were promoted as the "green" choice. Organizations frequently offer them as a promotional item free of charge. Adequate social awareness of the plastic crisis is vital for reduction strategies to work.

Many types of reusable bags are available on the market. They are often produced using materials that give the bag added strength; they are also heavier and more durable. Although more environmentally friendly than traditional single-use plastic bags, recycling reusable bags can be complicated, time intensive, and costly. Depending on their composition, reusable bags might have to be deconstructed in the recycling process to separate the different materials. Consequently, reusable bags are often not recycled. This means that millions of reusable bags end up in landfills at the end of their useful life. It is critical to consider the options available locally for the recycling or upcycling of reusable bags before they are widely adopted.

Biodegradable – does it do what it says on the bag?

In an effort to reduce plastic pollution, many governments have outlawed conventional plastic bags, allowing only the use and production of "biodegradable" bags. While petroleum-based plastic still dominates the market, there has been a growth in plastic produced from renewable resources. These products are often marketed as biodegradable or bio-based.

But there is a catch. The term "biodegradable" may be misunderstood by customers to mean bags that are fit for home composting or bags that break down in the environment naturally and quickly. In reality, the majority of biodegradable plastics only biodegrade under high temperatures. These conditions are met in incineration plants but rarely in the natural environment. Even bioplastics derived from renewable sources such as corn starch, cassava roots, sugarcane or from bacterial fermentation of sugar or lipids (PHA) do not automatically degrade in the environment and especially not in the ocean.

Biodegradable plastics can also be made from petroleum-based or a combination of petroleum and bio-based resources. Some bio-based polymers, such as polyethylene (PE) from bio-ethanol, are not biodegradable. The confusion among consumers may lead to improper disposal of plastics labelled as "biodegradable". These bags may also make recycling more difficult and more expensive if they are mixed in with conventional plastics.

Governments must ensure that a clear distinction is made between home-compostable and industrially compostable plastics. Consumers need to understand that "bio-based" refers to the origin of the resource used to make a product. It does not refer to how the product behaves in the environment after it is used.

A significant increase in bio-based plastics production to a level comparable to conventional plastics might negatively impact the production of food crops. Better labelling and consumer education are vital. If governments insist on switching to plastics that biodegrade in incineration plants, then clearly they must also invest in these plants and ensure that the different types of plastic waste are properly separated. Failure to do so could trigger bigger environmental problems.

SECTION 2

BUSINESS

Designing the future

Ultimately, our plastic problem is one of design. Our manufacturing, distribution, consumption and trade systems for plastic – indeed our global economy – needs to change. The linear model of planned obsolescence, in which items are designed to be thrown away immediately after use, sometimes after just seconds, must end. Governments must drive this change, holding manufacturers to account for the life cycle of their products. At the same time, companies that actively embrace their social responsibility should be rewarded for moving to a more circular model of design and production, incentivizing other companies to do the same. The private sector must innovate, adopting business models that reflect responsibility for the downstream impact of their products.

The overarching aim when it comes to innovation should be to reduce society's dependence on the unnecessary use of plastics, especially those made from fossil-fuel sources. Solutions exist but carry the risk of unintended consequences. A proper analysis of how alternative materials behave in the environment and the degree to which different options can be scaled up will be critical as businesses seek to innovate.

Today, the use of resources to manufacture conventional plastics is inefficient. End-of-life solutions for unwanted plastics are wholly inadequate. In other words, the current plastics economy is unsustainable. Plastic recycling can be an effective way of reducing the leakage of plastics into the environment. But the effectiveness of recycling is damaged if products are not designed properly. Chemicals added to plastic polymers, products made of mixed materials and food packaging contaminated with food waste make recycling difficult and costly.

Recycling can also lead to unintended consequences. PET drinks bottles are readily recycled. However, instead of producing new PET bottles, about 80 per cent of recycled PET is used for fibre production in, for example, the clothing industry. Fibres are readily lost from these fabrics during wear and washing, generating a significant source of microplastics in the environment. In addition, food and product packaging is often unnecessarily excessive and made from materials that are hard to recycle even in the most developed countries.

Companies should not wait for governments to act before changing their ways. The use of virgin micro-plastics in consumer products like toothpaste, shower gels and creams, should be phased out by businesses immediately.

Plastic products must also be designed to be as durable as possible to increase the number of times they can be reused. Unfortunately, marketing considerations often trump sustainability. This means that plastic products, like laptops, are thrown away when they could easily be upgraded by, in the case of laptops, simply installing a new computer chip.

Manufacturers and retailers also have a responsibility to inform consumers about their products. Consumers should be made aware of the plastic content of a product and its harmful additives, as well as its recyclability, reparability and compostability. This would allow consumers to make informed choices when buying plastic products. Recyclability could be reflected in the price of products and used as a marketing strategy.

What's it worth?

Plastic is so ubiquitous that it is often viewed as a material with no value of its own. This perception leads to littering and hampers recycling. It ignores the fact that plastics are high tech and complex materials. Consumers need to learn to value plastic if they are to see value in reusing and recycling the material. Retailers could introduce deposit and return schemes on some plastic products, like PET bottles, to encourage consumers to recuperate their deposit when they bring the product back to a designated collection point.

In several developed and developing countries, the introduction of Extended Producer Responsibility (EPR) and Deposit-Return Schemes has reduced littering from PET bottles and boosted the recycling sector. Germany, Japan and South Africa are a few among many of the successful examples of countries in which the responsibility for recycling used PET bottles is shouldered by manufacturers.

Alternative materials

Plastic products are cheap and convenient. Their abundance belies their social and environmental harm. Our increasing dependence on plastic has led us to ignore society's historic dependence on plants and animals for clothing, shelter, textiles and food storage. Many products do not need to be made with plastic. Existing or emerging technologies may have an important part to play as society seeks to wean itself off its dependency on traditional plastics. But alternatives to plastic have received scant attention, particularly for short-lived plastics like packaging. UN Environment has conducted research into some of the most promising materials currently available as it seeks to inspire and inform entrepreneurs, start-ups and established businesses that are keen to innovate but unsure of their options. These alternatives to plastic fit into three broad categories: natural polymers; biomass-based, compostable, synthetic biopolymers; and reusable, durable, non-plastic materials.

1. Natural polymers

One of the main differences between synthetic or semi-synthetic polymers and natural polymers (material that comes from plants and animals) is that the latter biodegrade very rapidly when not maintained by a living organism. This is why the preservation of ancient fabrics, organic artefacts and human corpses is so rare. It is why we are not buried under enormous quantities of dead plants and animals. Most of these materials will also biodegrade relatively rapidly in the ocean.

Plant and animal-based materials have provided for many of society's domestic needs for millennia. There is evidence that cotton has been used to make fabrics for at least 5,000 years. A key question is whether the shift away from natural fabrics to synthetic and semi-synthetic polymers can be reversed without causing more harm. This consideration is key as societies seek to react quickly to political decisions, such as the introduction of bans on thin-film synthetic shopping bags.

2. Biomass-based compostable bio-polymers

Most synthetic polymers are not biodegradable under normal environmental conditions, no matter whether they are derived from fossil fuels or renewable biomass. Marketing a product as "biodegradable" can be misleading (see box on page 8). Some polymers do biodegrade when they are composted, but even this can lead to confusion among consumers. "Compostable" can refer to a process that takes place in either an industrial setting or a domestic setting. The difference is critical. In many cases, labelling a product or polymer as being "compostable" means it only composts in an industrial composting system, where temperatures can be maintained at around 60°C for many weeks. Normal domestic/garden compost bins or heaps operate at much lower temperatures, meaning these polymers will not biodegrade in this environment.

- ***Starch***

The wide availability of starch has generated considerable interest in the potential for starch-based products to replace conventional plastics. Thermoplastic starch is already used to protect packaged goods in transit. Research has focused on whether it could also replace styrofoam, especially for food packaging. Much of the research focuses on cassava starch, an important staple crop in parts of Asia, Africa and South America. Starch-based products are very promising but scaling up their manufacture means ensuring that our ability to produce food is not put at risk.

Further work is required to maximize the potential of starch-based bio-composites to replace conventional plastics. Research also suggests that starch-based shopping bags retain 85 per cent of their original mass after six months in the ocean. Studies in the Mediterranean Sea suggest the bags significantly alter the sediment pore water chemistry and impact species of seagrass. On land, starch-based materials are readily compostable, in both a domestic and commercial setting. If starch-based products are widely adopted then ensuring they do not leak into the ocean will be just as critical as limiting the leakage of conventional plastics.

- ***Non-starch thermoplastic bio-composite***

Whereas starch-based products require land to produce the raw material, possibly threatening food production, films made from alginate do not compete with our ability to grow food. Alginate-based thermoplastics are still under development but show great promise. Cutin is another possibility. Research shows that the waste from tomato production could be used in relatively low cost and scalable technologies. Greater use can be made of waste products from agricultural production.

- ***Synthetic biomass-based polymers***

A variety of plant-based and animal-based raw materials can be used to synthesize polymers. Cellulose and starch are the most common sources, but proteins and fats can also be used. Polylactide (PLA) and polyhydroxylkanoates (PHA) have been synthesized in significant volumes and marketed as "biodegradable". PLA is based on the bacterial fermentation of sugars derived from a variety of biomass sources. However, problems may arise when food crops are deliberately grown to produce these biomass-based polymers because this may lower the availability of food for humans. The use of water, fertilizer, biocides and energy to produce these crops may also damage the environment. If agricultural waste is used, or if the products are composted or anaerobically digested at the end of their lives, then the environmental credentials of PLA and PHA are easier to defend.

PLA is becoming more popular as a substitute for conventional plastics in the catering sector, where food waste and used PLA plates, cups and cutlery can be collected and the combined waste sent for either industrial composting or anaerobic digestion. This approach works best in a controlled, closed-loop environment that prevents cross contamination with waste from conventional plastics, thus making recycling easier. Products could be designed to make it easier for consumers to distinguish between different types of plastic to prevent them from being mixed together. Some research has also explored the possibility of producing lactic acid from methane by fermentation. The potential to close the loop on PLA production by generating methane from the anaerobic digestion of PLA waste is exciting.

Governments need to think carefully about the consequences of giving subsidies to certain sectors to ensure that the perceived benefits (social, economic, environmental or political) are balanced against the real cost, especially in terms of environmental damage. For example, subsidizing maize production as a raw material for biofuels or biomass-based polymers makes little environmental sense if accompanied by excessive use of water, fertilizer and biocides. There may be a social and economic benefit to the farming community but the overall cost from environmental degradation may be far greater.

3.Reusable objects
In the past, containers have been made from clay, leather, metal, glass and other materials. This changed with the birth of cheap plastic alternatives. Today, estimates suggest that we use one million plastic bottles per minute. Re-fillable containers for food and drink fluids are an obvious alternative to plastic containers that are thrown away, many after only one use. The demand for single-use PET water bottles could also be significantly reduced if clean drinking water were made available for individuals so they could fill reusable containers.

Upcycling

We have found additional uses for many non-plastic goods whose primary lives have come to an end. This method can be applied to a range of items, such as wooden chopsticks, fabrics that have been worn out, and "waste" materials from the manufacturing process. Promoting these approaches and adopting reusable products will reduce the overall demand on the Earth's resources and provide an alternative to their plastic equivalents.

Re-packaging: shifting the balance

The wider adoption of alternatives provides an opportunity for us to move away from the linear "produce—use—dispose" model that is responsible for much of the waste we generate. Adding natural materials and biomass-based bio-polymers, such as PLA, PHA and starch blends, opens up new opportunities for closed-loop and more circular "produce—use—re-use" patterns. However, for this to work, more plastic waste, especially food-contaminated waste, needs to be composted or sent to anaerobic digesters. This can only happen if these facilities are available. Anaerobic digestion provides other advantages, including the ability to generate energy from the waste product. Compostable fossil fuel-based polymers can also be used in industrial composting or anaerobic digestion. Provision of industrial composting and/or anaerobic digestion facilities is necessary before PLA and PHA are introduced into the retail sector. These products are not suitable for uncontrolled retail use, typified by the "fast food" sector. Digesters require a regular supply of waste material of similar quality in order to work efficiently, as well as a skilled operator. This, and the high start-up costs, may hinder their construction.

There are two key caveats to promoting the use of PLA, PHA and starch-blend products more widely: i) they have to be excluded from the recycling stream to avoid compromising the quality of recycled conventional polymers; and ii) PLA and PHA will behave like conventional polymers in the aquatic environment and contribute to an increase in ocean plastics if not disposed of correctly.

Fibre production

Textile production has been transformed by the introduction of synthetic and semi-synthetic fibres. But textiles represent a very substantial source of micro-fibres in the ocean, introduced largely via wastewater that flows into our seas. Fibres of synthetic polymers do not biodegrade in the ocean. Unfortunately, it is unlikely that the present demand for textiles will decrease unless there is a major change in the way goods are produced. Studies suggest there is the potential to promote more sustainable use of textiles in the clothing sector by adopting the principles of "slow fashion" and with greater attention to the longevity and repair of products, and to reducing textile waste. However, it is not clear whether this philosophy can make a significant difference outside niche markets in wealthier societies.

Life-cycling

Most analyses that look at the life cycle of a product fail to include its end-of-life phase. This undermines the validity of these studies, which tend to conclude that adopting conventional plastics is more beneficial than using natural materials or biomass-based biopolymers. Environmental economists need to work with agronomists, material scientists, environmental scientists and others to devise more reliable techniques for proper life-cycle analyses. These studies should also factor in the use of waste materials for manufacturing new products, as well as the benefits of adopting a network of commercial composting and anaerobic digestion facilities. This will help businesses select the most beneficial materials when deciding what alternatives to use.

SECTION 3

INDIVIDUALS

Individuals are increasingly exercising their power as consumers. People are turning down plastic straws and cutlery, cleaning beaches and coastlines, and second-guessing their purchase habits in supermarket aisles. If this happens enough, retailers will quickly get the message and ask their suppliers to provide better alternatives.

Consumers must not only be actors but drivers for the behaviour change that must happen upstream. The plastic bag bans in some countries followed sustained pressure by citizens. In Bali, two teenagers led a four-year campaign to persuade the authorities to ban plastic bags. The government eventually committed to phasing out plastic bags by 2018. Similarly, in New Zealand, high school students called on the government to impose a 10 per cent levy on plastic bags in supermarkets. Public support for their proposal led mayors across the country to call on the government to impose a nationwide levy. Ultimately, individuals must act as both consumer and informed citizen by demanding sustainable products and embracing sensible consumption habits.

Keeping your neighbourhood clean can also have a profound impact. One of the most robust findings in litter research is that people litter less and use the bin more in places that are kept clean. This means that cleanups are not just about picking up litter. They have a wider impact by raising awareness, educating others about plastic waste and reducing the urge to litter.

Each of us has the power to change the way we use and dispose of plastics. Guided by the principle "if you can't reuse it, refuse it", here are some of the things we can all do to reduce plastic waste, recycle more and pressure businesses and manufacturers to design better products.

- **Separate waste for recycling**
- **Avoid single-use goods like cutlery and cups**
- **Avoid buying over-packaged products**
- **Use fewer single-use plastic bags**
- **Ask food delivery companies to exclude plastic cutlery from deliveries**
- **Use re-fillable containers for food and drinks**
- **Find out what local options exist to reduce your plastic footprint**
- **Up-cycle products you own where possible**
- **Check how recyclable products are before you buy them**
- **Learn more about the alternatives to plastic**
- **Educate friends and family about the plastic crisis**
- **Encourage local schools to educate their pupils about plastic**

Informed consumers can play a decisive role in promoting more sustainable production of plastic products. However, this will require governments, manufacturers and retailers to ensure that products are properly labelled. In targeting consumer behaviour, clear, simple and concise information about a product will empower individuals to make better decisions.

Social pressure can trigger change in both policymakers and manufacturers and eventually help reduce plastic pollution. Public awareness is also vital for the success of government strategies to curb plastic pollution, like the banks and levies discussed above. Similarly, awareness raising, monitoring and communicating progress to the public helps build confidence and strengthen the public's commitment to the cause.

CONCLUSION

It is neither possible nor desirable to remove all plastic from society. However, given the scale of today's plastic crisis, alternative materials have a significant role to play in reducing our dependence on plastic, whose cost and convenience has seen production of the material skyrocket in recent decades. This trend is set to continue, meaning that our ability to deal with plastic waste, which is already beyond breaking point, will deteriorate further.

Governments are slowly waking up to the problem. Bans on plastic bags and styrofoam can effectively curb the amount of plastic waste dumped in our environment. They also create an incentive to promote the use of bags constructed from natural materials while providing businesses with an opportunity to fill the gap. But the enforcement of government regulations has often been poor. Single-use plastic bags continue to be widely used and mismanaged despite bans and levies. In contrast, in Japan, where no bans are in place on single-use plastic, a highly effective waste management system accounts for relatively limited leakages of single-use plastics in the environment. By working together with industries and consumers, governments can support the development and promotion of sustainable alternatives by building infrastructure, drawing up new legislation and funding research and development.

Transitioning to more environmentally suitable alternatives to conventional plastics will be a lengthy process. In the meantime, strengthening circular thinking and waste management systems will help reduce plastic pollution. The use of alternatives must be part of a broader strategy towards more sustainable production, particularly of packaging and other single-use items. This will mean redesigning products, reducing waste and improving recycling. We must also balance the aim of reducing plastic packaging waste with reducing food waste. Scaling up potential solutions to support a mass market remains a big barrier. Addressing issues like the supply of raw material, the availability of appropriate skills, access to financing, infrastructure and the level of current technology will be key. Businesses must take a close look at how their products are designed and disposed of as they seek to develop environmentally friendly products that are easier to recycle. They must be held to account for the impact their products have on the environment.

Biomass-based biopolymers such as PLA, PHA and TPS show great potential as alternatives, especially for packaging and other single-use items, provided they are used in closed loop-systems. But their promotion as a "greener" alternative is unjustified without industrial composting or anaerobic digestion facilities. They are not suitable for dispensing "fast food" in uncontrolled public spaces. Nor will the increasing use of PLA, PHA and TPS and similar biopolymers reduce the amount of plastic waste reaching the ocean or ending up in landfill. In addition, there is a risk that such polymers will contaminate recycling waste streams. The use of natural materials, either directly or as a biomass source, depends on prices in the agricultural and horticultural sectors. These can be highly variable and unpredictable. Building in flexibility in the selection of different materials will be an advantage.

Moving towards more closed-loop, carbon-neutral production cycles, including the use of industrial composting and anaerobic digestion, will demonstrate the beneficial use of waste, and should promote more effective waste management and wider acceptance among the public. Natural alternatives to conventional plastics, and the use of biomass-based biopolymers,

have an important role to play in such systems. Governments have a moral responsibility to examine the consequences of subsidizing certain sectors to ensure that the perceived benefit (social, economic, environmental or political) is balanced against the actual cost, especially of environmental damage. The public and private sectors must fully cost the social and environmental impacts of their current business models. As a rule, the precautionary approach and polluter pays principle must guide the transition to more sustainable products and practices.

Additional research must be conducted into the behaviour, fate and effects of natural materials, semi-synthetic polymers and biomass-based biopolymers in the natural environment. Further research into the use agricultural and horticultural waste is necessary as we explore alternatives to conventional plastics.

Governments and businesses must ensure that materials are clearly labelled as suitable for industrial composting. They must discourage the use of the term “biodegradable” without clarifying the conditions under which biodegradation occurs. It is essential to ensure products are adequately labelled so that uses and consumers are provided with clear, comprehensible and accurate information of which to base purchase decisions.

All elements of society have a role to play in exploring opportunities for reducing conventional plastic use and replacing it with alternative materials or biomass-based biopolymers. There is a need for innovation and entrepreneurship, which could be encouraged by competition. Governments and individuals must raise awareness about the impact plastics have on society and the environment and seek to educate people about the potential of alternative materials.

Ultimately, there is no single, one-size-fits-all solution to the current plastic crisis. Governments, businesses and individuals will all play a major role in weaning society from its dependence on a material that continues to cause havoc in the environment.

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Notes

Notes

#BeatPlasticPollution

If you can’t reuse it, refuse it!

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