



The Challenge of Single-Use Plastic

Fabian M. Dayrit, PhD

Vice-President, National Academy of Science and Technology Philippines (NAST PHL)
Professor Emeritus, Department of Chemistry, School of Science and Engineering
Ateneo de Manila University

Single-use plastic accounts for about 36% of total plastic production, and represents the largest use of plastic. Because single-use plastic is meant for disposal and because of its volume, it is the most visible and problematic type of plastic pollution. We cannot solve the problem of single-use plastic using the 3Rs – reduce, reuse, recycle – because this type of plastic is not designed to be reused and is difficult and uneconomical to recycle. Further, the management of plastic waste assumes that there is efficient recovery, which is not present in most developing countries. We need to expand the 3Rs to the 5Rs – redesign, reduce, reuse, recover, recycle. All plastic products must be redesigned to make them inherently recyclable and there must be a more efficient system of recovery. Further, all sectors – industry and commerce, the consumer, and government – must participate in the implementation of the 5Rs:

- **Industry:** Redesign plastics to make them inherently recyclable with safe and environmentally benign additives. The producer should retain product stewardship and should internalize the cost of management of waste, recycling and disposal which result from the use of its product. This responsibility extends to the distributors and sellers of the product.
- **Consumer:** Should be properly informed and educated regarding the proper use of plastics and should be responsible to reduce and reuse plastic products, and to dispose of these properly.
- **Government:** Formulation of laws and regulations for plastic products and provide economic and other incentives for research into the recycling of plastic waste and the redesign of plastics. Government should also implement a comprehensive plastic waste management system which ensures efficient recovery of plastic waste.

SCIENCE ADVISORY 2019-2

Published by the National Academy of Science and Technology Philippines (NAST PHL).

A contribution from the Mathematical and Physical Sciences Division of NAST PHL.

NAST PHL is the country's premier advisory and recognition body on science and technology. NAST PHL is an attached agency to the Department of Science and Technology.

Plastic has been transforming our lives since the first fully synthetic plastic was commercially produced in 1907 (Bakelite) from coal tar. The availability of cheap petroleum, especially after World War 2, significantly expanded the development and widespread use of plastic. Since the 1950s, plastic has become the most widely produced material. Today, the widespread use of plastic has transformed many aspects of the economy and our daily lives. Its ubiquity and low cost have resulted in the generation of large amounts of waste and widespread pollution. The ecological and health impacts of plastic pollution are acknowledged to be vast but still not fully understood. The challenge before us is how to manage plastic so that we can avoid waste and prevent pollution.

Given the important role that plastic plays in modern society and the economy, we must adopt a strategy that manages plastic holistically: this should not be viewed only as a challenge of plastic pollution or plastic waste; it is a challenge to manage plastic from its design, to its manufacture, distribution, and use. Further, this strategy must involve all sectors, in particular, industry and commerce, consumers, and the government.

Inadequacy of the 3 Rs

Most strategies used to address the problem of plastic waste are based on the approach of the 3Rs – reduce, reuse, recycle. This strategy, which originated in the United States in the 1970s, has been adopted worldwide. However, despite its wide use, the 3Rs has failed to curb the problem of plastic pollution, especially in less developed countries. The 3Rs put most of the burden on the consumers and the government, and less on industry that produces the plastics. Consumers are asked to reduce and reuse plastic products. However, our consumption-driven economy makes it illogical to expect consumers to reduce plastic consumption and there is only so much that consumers can do to reuse plastic waste.

The 3Rs are inadequate for two reasons:

- First, this strategy assumes that there is efficient *recovery* of waste but most governments in less developed countries are unable to do this. Also, while recovery may work for plastic waste which retains some value, it does not work for those which do not have any value, such as sachets and thin plastic bags. These materials have been identified as the major plastic pollutants in the Philippines.
- Second, half of the plastics that are produced, in particular, the single-use plastics, are *not designed to be recycled*. Many plastics contain additives which are harmful and which make recycling potentially hazardous. These include plasticizers, such as phthalates and bisphenols, and fire retardants, such as polybrominated compounds and toxic metals. The presence of such additives poses a risk in the reuse and recycling of plastics.¹ Further, many plastics, in particular, thermoset plastics, are not recyclable. Globally, less than 9% of plastic waste is actually recycled.²

From 3Rs to 5Rs

The inadequacies of the 3Rs should be replaced with the 5Rs – Redesign, Reduce, Reuse, Recover, Recycle – and there should be a clear assignment of responsibilities to each of the main participants, namely, industry and commerce, the consumer, and the government.

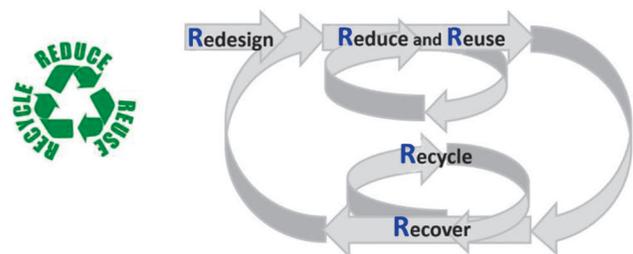


Figure. From the 3Rs to the 5Rs. The 5Rs assign responsibility to all sectors: industry and commerce, the consumers, and the government.

Single-use plastic

Single-use plastic accounts for about 36% of total plastic production, and represents the largest use of plastic. Because single-use plastic is meant for disposal and because of its volume, it is the most visible and problematic type of plastic pollution. The International Union for Conservation of Nature (IUCN) has identified single-use plastic as “the most widespread problem affecting the marine environment.”³ In March 2019, the 4th UN Environment Assembly committed to “significantly reduce single-use plastic products by 2030.”⁴ Thus, the first phase to solve the global challenge of plastic waste is focused on single-use plastic.

Single-use plastic^{5,6} can be divided into several categories based on the use and type of plastic (see Table). This will provide the basis for the development of a systematic program for the replacement and deliberate phase-out of each type of single-use plastic. This requires the participation of all sectors.

Life cycle analysis (LCA)

The use of plastics often entails choices between two or more options. Life cycle analysis (LCA) is a systematic, evidence-based method

that should be used to evaluate the environmental impact of a product starting from the raw materials, manufacture, distribution, use, reuse, and recycling. LCA can be used to analyze the recent trend to return to the use of paper bags to avoid the use of plastic bags. Numerous LCA studies on this issue by various groups have concluded that plastic bags have a lower environmental footprint than paper bags, even for single-use plastic bags, provided that waste management is efficient.¹

Using LCA, the key recommendations for the Philippines are: 1. To discourage the use of paper shopping bags; 2. To promote the use of multi-use plastic shopping bags; and 3. To improve waste management.

Redesign, Reduce, Reuse, Recover, Recycle: All sectors have a role

Plastic must be viewed holistically in terms of its functions and life cycle. We should adopt a more holistic approach, which expands the traditional 3Rs to the 5Rs. Plastic must be redesigned to be recyclable and the efficient recovery of waste plastic must be part of this now closed-loop cycle.

Table. Proposed strategy to tackle various types of single-use plastic according to their use and type of plastic material. This strategy requires the participation of all sectors.

Classification of single-use plastic	Proposed measures
1. Consumer products	
• Carrier bags (sando bags)	• Phase out, replace with sturdy multiple use plastic bags • Oxo-degradable bags are not recommended • Paper bags are not appropriate replacement
• Plastic (PET) bottles and caps	• Promote use of own containers and utensils • Reintroduce system of bottle retrieval
• Sachets	• Develop alternative mode of distribution and sale
• Personal sanitary products (diapers, napkins, wet wipes), cosmetics and personal care	• Develop alternative products • Develop alternative packaging
• Food packaging, disposable utensils	• Promote R&D on biodegradable plastics
2. Styrofoam for packaging	• Develop alternative packaging which does not result in disposal
3. For medical use: pharmaceutical products, disposable gloves, plastic implements	• For further study; used material may be biological hazard

All sectors – industry and commerce, consumers, and the government – play important roles in the management of plastic.

1. Industry: Redesign plastics to make them inherently recyclable with safe and environmentally benign additives.
2. Industry: Extended Producer Responsibility: The producer retains product stewardship and should internalize the cost of management of waste, recycling, and disposal which result from the use of its product. This responsibility extends to the distributors and sellers of the product.
3. Consumer: Should be properly informed and educated regarding the proper use of plastics and should be responsible to reduce and reuse plastic products, and to dispose of these properly.
4. Government: Formulation of laws and regulations for plastic products and provide economic and other incentives for research into the recycling of plastic waste and the redesign of plastics.
5. Government: Implement a comprehensive plastic waste management system which ensures efficient recovery of plastic waste.

Finally, it should be emphasized that the challenge of single-use plastic, big as it is, accounts for about 36% of total plastic production. The management of single-use

Experts' talks about plastics and plastic wastes during the NAST PHL Annual Scientific Meeting on July 10-11, 2019, are available on the **NAST PHL Talks YouTube channel**.

plastics represents only the first goal in the overall management of plastics. We should also begin to enact measures and invest in R&D to address the challenges posed by the remaining 64% of the plastic that we produce.

References.

- ¹ Halden RU (2010). Plastics and Health Risks. *Annu. Rev. Public Health* 31:179–94.
- ² d'Ambrières W (2019). Plastics recycling worldwide: current overview and desirable changes. *Facts Reports* Special Issue 19: Reinventing Plastics. Downloaded on Nov. 19, 2019 from: <https://journals.openedition.org/factsreports/5102>
- ³ IUCN (2018). Marine pollution. Downloaded on Nov. 18, 2019 from: https://www.iucn.org/sites/dev/files/marine_plastics_issues_brief_final_0.pdf.
- ⁴ UNEP (2019). UNEA-4 Commits to Global Environmental Data Strategy, Reducing Single-use Plastics. Downloaded on Nov. 18, 2019 from: <https://sdg.iisd.org/news/unea-4-commits-to-global-environmental-data-strategy-reducing-single-use-plastics/>
- ⁵ Geyer R, Jambeck JR, Law KL. (2017). Production, use, and fate of all plastics ever made. *Sci. Adv.* 3, e1700782 and Supplementary Materials.
- ⁶ UNEP (2018). SINGLE-USE PLASTICS: A Roadmap for Sustainability. Downloaded on Nov. 18, 2019 from: <https://www.unenvironment.org/resources/report/single-use-plastics-roadmap-sustainability>

ABOUT NAST PHL

The National Academy of Science and Technology Philippines (NAST PHL) is mandated to recognize outstanding achievements in science and technology and to serve as reservoir of competent scientific and technological manpower for the country (Presidential Decree No. 1003-A, December 17, 1976). By virtue of Executive Order 818 (July 16, 1982), the Academy was formally charged with the function of advisory body to the President and the Cabinet on policies concerning science and technology in the country.

National Academy of Science and Technology, Philippines (NAST PHL)

3rd Level, Science Heritage Building,
DOST Complex, General Santos Avenue, Bicutan,
Taguig City 1631 Metro Manila, Philippines
Direct Lines: (632) 8838-77-39/66/92;
Trunklines: (632) 8837-2071 to 82 ext. 2170 to 76
Fax No.: (632) 8837-3170
e-mail: secretariat@nast.dost.gov.ph
URL: www.nast.ph