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german cooperation
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Rethinking Plastics
Circular Economy Solutions to Marine Litter


SCOPING REPORT

# Single-use plastic items and their alternatives used in food consumption, takeaway and delivery in the Philippines

Scoping of available data on the current consumption of single-use plastic items and their alternatives used in food consumption, takeaway and delivery, and their advantages and disadvantages in terms of environmental, social and economic aspects

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Prepared by:

DELTA TIERRA CONSULTANTS, INC.

Prepared for:

Deutsche Gesellschaft fUr Internationale Zusammenarbeit (GIZ) GmbH

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## EXECUTIVE SUMMARY

There is widespread recognition that urgent actions are needed to abate the environmental, social and health impacts of single-use plastic (SUP) wastes locally and globally.  In the Philippines, about 760,000 tons or 35% of the total plastic consumption is leaked to the environment. Plastic recycling rate is low at 9%.

The current system work in a linear take-make-dispose approach and is clearly not sustainable. A shift to a circular economy is requisite, where the value of products is retained for as long as possible. This approach requires not only a change in the way products are designed and manufactured, but also how these products are used in daily activities.

There is a need for assessing alternative solutions that minimize the use of SUPs for applications in which they are not essential. Efforts should be made to ensure that alternative options to SUPs are grounded on science-based sustainability information and that unintended outcomes are anticipated. This report provides a literature review and analysis of life cycle assessment (LCA) studies comparing different types of SUP products with alternatives that are currently available in the Philippines. Efforts of comparison of impact potentials between these different studies were approached with caution, with consideration to the differences of the conditions in the studies with the Philippine setting.

The following are the main conclusions drawn in the preparation of this report:

- The order of preference for action to reduce and manage plastic wastes should follow the waste management hierarchy, according to which the avoidance of waste should be preferred over all other options.
- Simply replacing fossil-based plastics with another material (e.g. bioplastics, oxo-degradable or biodegradable plastics) in the single use items tends to simply shift the environmental impacts and create other problems (UNEP, 2021c). Consequently, substitution will not lead to an overall better environmental benefit.
- Reusable products have a lower environmental impact than single-use products. Increasing the reuse rate as much as possible will lower the product's environmental impacts (Stuber-Rousselle, 2021).
- How wastes are managed at the end-of-life phase (e.g. landfilled, littered in the environment, recycled, composted) have a significant influence on the environmental impacts of each product (UNEP, 2021c). Hence, the sustainability of products should be assessed considering the most feasible end-of-life option.
- While single-use plastics often appear as the cheapest option, it should be recognized that its "true" cost will often result in higher price once externalities are factored in such as the health and environmental impacts over the product's life cycle, ecosystem impacts, biodiversity impacts, cost of waste management, and the negative economic impacts in tourism and fisheries.

While Republic Act 9003 or the Ecological Solid Waste Management Act of the Philippines, the primary legislation that governs solid waste management in the country, provides the necessary policy framework and institutional mechanisms that are built around the principles of waste management hierarchy, it is weakly enforced and not fully implemented. This study aims to provide support to the government to help recognize what plans and programs that are in the existing laws need to be prioritized or reformed. It shall also reinforce the strategies laid out in the National Plan of Action for the Prevention, Reduction and Management of Marine Litter (NPOA-ML).

Key recommendations that policymakers should consider based on the conclusions and identified challenges in the adoption of alternatives to SUPs are provided below:

*Addressing SUP pollution through systems change*

Addressing single-use plastic products requires systems change (UNEP, 2021c). A combination of circular economy approaches across the life cycle of plastic products and its alternatives and a mix of policy interventions are needed to reduce the environmental impacts of SUPs. Policies that can be considered include bans or regulations on the production and use of certain SUPs, Extended Producer Responsibility (EPR) schemes, market-based instruments such as tax or levy on SUPs, encouraging circular business models, deposit refund schemes, subsidies supporting innovation, production and research efforts on alternative materials, education and awareness raising, and voluntary agreements/ initiatives by the industry and various stakeholders.

*Using life cycle thinking in policymaking*

LCA studies on SUPs and its alternatives show that life cycle thinking, coupled with social impact assessment, is an important evidence-based tool to identify possible trade-offs that may arise in the selection of alternatives over another. Hence, life cycle assessment should be a critical part of policy interventions targeted at supporting materials innovation and minimizing the negative impacts of SUPs. End of life scenarios should also be included in the LCA to assess which end-of-life options are most environmentally viable and which waste management infrastructures should be prioritized.

Recognizing the importance of life cycle approach in policy making, there is a need to build more capacity on LCA and conduct more local context-based LCA studies to aid in policy decision making when identifying the best alternatives.

*Replacing single-use plastic products with reusable products*

In view of the waste management hierarchy and the conclusions of this report, the government should support, promote and incentivize actions that will extend the service life of products for as long as possible, by replacing single-use plastic products with reusable or multi-use products. Encouraging the adoption of circular business models for alternative food packaging and delivery systems such as the purchase of products in refillable containers or reusable packs and take back mechanisms for reusable food packaging/ containers will help achieve wider use of reusable products.

*Addressing sustainability issues from using biodegradable and bio-based alternatives*

Plastic products from waste such as agricultural wastes should be preferred over bio-based materials that could be used as food in order to reduce potential conflicts with food production (Löw, et.al, 2021). Furthermore, standards for the consistent labeling on plastic products, biodegradable and bio-based plastics should be mandated, including information on the post-use management and impacts of wastes so the public understands how to properly manage their wastes, and to facilitate proper sorting of wastes.

***Providing support for start-ups of SMEs***

To support start-ups of SMEs for alternative materials and adopting circular business models, credit schemes for environmental technology promotion funded by public budgets or private foundations could be provided (GIZ, 2022). Financial support should also be provided not only for research and development projects on alternative materials, but should be extended to pilot testing of production by the industry, as well.

# GLOSSARY

### Definitions Related to Biodegradability

| | |
|---|---|
| *Biodegradable* | Capable of decomposing rapidly by microorganisms under natural conditions (aerobic and/or anaerobic) *(European Environment Agency)*<br><br>*NOTE: Terms such as bioplastics, bio-based, degradation, disintegration, oxo-degradation, and oxo-biodegradation are NOT synonyms with biodegradable.* |
| *Bio-based* | The material or product is (partly) derived from biomass (plants). Biomass used for bioplastics stems from e.g. corn, sugarcane, or cellulose. *(European Bioplastics)* |
| *Degradable Plastic* | A plastic designed to undergo significant change in chemical structure under specific environmental conditions resulting in a loss of some properties that may vary as measured by standard test methods appropriate to the plastic and the application in a period of time that determines its classification *(Philippine National Standards (PNS) 2097:2014 Packaging and packaging materials Plastic Shopping bags Specification)* |
| *Oxo-degradation* | Degradation identified as resulting from oxidative cleavage of macromolecules *(European Standards Authority)* |
| *Compostable* | Through microbial activity, the controlled biological treatment of the biodegradable components of used packaging which produce compost and, in the case of anaerobic digestion, also methane. *Note: landfilling and littering are not considered as organic recycling (PNS ISO 18606:2016 Organic Recycling, definition 3.9)* |
| Compostable-industrial | Capable of being biodegraded at elevated temperatures under specific conditions and time scales |
| Compostable-domestic | Capable of being biodegraded at low to moderate temperatures, typically found in a domestic compost system |

| | |
|---|---|
| Bio-based plastics | Plastics produced from polymers derived from biomass or plant-based sources such as starch, cellulose, or lignin. Bio-based plastics are not always made from 100% renewable resource and can be composited with fossil-based materials. |

## Definitions Related to Life Cycle Assessment Impact Categories

| Impact Category | Description |
|---|---|
| *Global Warming Potential (GWP)* | Increasing temperature in the lower atmosphere, caused by the emission of greenhouse gases (e.g., CO2, methane, nitrous oxides) which reflect or absorb infrared radiations reflecting off Earth's surface. This causes regional climate changes, melting of polar glaciers, and sea-level rise. |
| *Ozone Depletion* | Environmental impact related to the thinning of the ozone layer caused by ozone depleting substances emitted by different forms of human activities. The depletion of ozone in the stratosphere makes it ineffective to screen out much of the UV rays from the sun and can cause serious damages to plants, animals, and humans. |
| *Acidification* | Environmental impact associated with the apparent decrease in the pH level of terrestrial and aquatic ecosystems, usually caused by emission of chemicals (e.g. sulfur oxides, nitrogen oxides, and ammonia) which leads to damages in ecosystem populations. |
| *Photochemical Ozone Formation* | The formation of ozone at the troposphere (ground level), also known as Photochemical Oxidant Formation, (Photochemical) Ozone Creation, or Ozone Formation.<br><br>At the ground level, ozone acts as a secondary air pollutant (also called summer smog) formed by the reaction of sunlight on carbon monoxide, and reactive hydrocarbons (e.g., ethane) in the presence of nitrogen oxides and volatile organic compounds. At certain concentrations, ozone causes damages to vegetation and human health. |
| *Eutrophication* | The enrichment of aquatic ecosystems with nutritional elements (e.g., nitrogen and phosphorus compounds), causing excessive algae growth, which releases toxins harmful to higher energy forms, and reduces light and oxygen in the water, harming other aquatic life. |

| Impact Category | Description |
|---|---|
| *Human Toxicity* | This is the impact to the level of functional state of a person to adequately cope with his/her daily activities by the absence of diseases and impairment. This is also the impact factor which can represent the social aspect of sustainable production. |
| *Ecotoxicity Potential* | Ecosystem impact of the emission of toxic substances to air, water, and soil, which can affect in a global, continental, or local scale. |
| *Abiotic Depletion* | Use of natural resources, including minerals, energy and fossil fuels. The natural resources can be renewable (quickly replenished) or non-renewable (not replenished within 500 years). |

# ABBREVIATIONS

| | |
|---|---|
| BMZ | German Federal Ministry for Economic Cooperation and Development |
| DOH | Department of Health |
| DUH | Environmental Action Germany |
| EPR | Extended Producer Responsibility |
| EU | European Union |
| FDA | Food and Drugs Administration |
| GAIA | Global Alliance for Incinerator Alternatives |
| GWP | Global warming potential |
| HDPE | High-density polyethylene |
| ICC | International Coastal Cleanup |
| LCA | Life cycle assessment |
| LDPE | Low-density polyethylene |
| LGU | Local government unit |
| MFA | Material flow analysis |
| NPOA-ML | Philippine National Plan of Action for the Prevention, Reduction and Management of Marine Litter |
| NSWMC | National Solid Waste Management Commission |
| pcs | pieces |
| PE | Polyethylene |
| PET | Polyethylene terephthalate |
| PLA | Polylactic acid |
| PP | Polypropylene |
| PS | Polystyrene |
| PSA | Philippine Statistics Authority |
| rPET | Recycled polyethylene terephthalate |
| SMEs | Small and medium enterprises |
| SUPs | Single-use plastics |
| UNEP | United Nations Environment Programme |
| USA | United States of America |
| XPS | Extruded polystyrene |

# 1. INTRODUCTION

## 1.1 Background

Single-use plastics (SUPs) such as takeaway containers, drinking bottles, drinking cups, plastic bags and cutleries have become the material of choice for many of the food products we consume today. Plastic packaging has become necessary in the food supply chain to protect food and prevent spoilage. Plastics are lightweight, easily molded into desired shapes, cheap and are conveniently suitable for an on-the-go lifestyle.

SUPs have transformed the consumer's habits on food consumption. The increasing trend towards food delivery and takeaway, coupled by the emergence of online food delivery platforms has led to the increased generation of single-use plastic wastes. Around 4.8 to 12.7 million tons of plastic wastes are leaked into the ocean every year, of which 40 to 50% are SUPs (Jambeck, 2015). The Philippines contributes the third largest share of mismanaged plastic waste to the global marine plastic pollution (Hanna and Max, 2018).

Given that plastics are non-biodegradable, they accumulate in the environment when not managed properly. These find their way in canals and river systems, clogging drainage and increasing susceptibility to flooding. In the marine environment, plastic litter can physically or chemically harm marine life and can negatively impact biodiversity and ecosystem functions. For instance, plastics can block sunlight from reaching planktons. This prevents them from producing food and providing oxygen in the ocean, affecting all other marine creatures as planktons are the basic building block for all other marine creatures.

When plastics degrade to smaller pieces called microplastics, it can contain residues of toxic plastic additives. Moreover, it can adsorb other harmful chemicals such as pesticides, posing health risks as they get ingested by marine life and possibly by humans as they move up the food chain.

Another environmental drawback of plastics is that these are sourced from non-renewable fossil fuels. Hence, more plastic production means more demand for fossil fuel and generation of more greenhouse gases during its manufacturing, contributing to climate change. However, unlike biodegradable materials that release greenhouse gases during decomposition, plastics do not contribute to increased greenhouse gas in the atmosphere unless these are open-burned or incinerated.

Plastic pollution has also an effect on society. For example, it can deter people from visiting beaches. It can also pose threat to livelihood like fishing and tourism activities. Hence, marine litter is not just an environmental issue but also poses health, social and economic challenges to our society.

The COVID-19 pandemic has aggravated the already existing environmental threats arising from the plastic wastes. Consumer behavior shifted from restaurant dine in to online food delivery services. The growing reliance on food deliveries also meant increased consumption of single-use plastic food and drink containers, cutlery and drinking straw.

It is becoming more widely recognized that urgent actions are needed to abate the plastic waste problem locally and globally. The current system work in a linear take-make-dispose approach and is clearly not sustainable. There is a need to shift to a circular economy where the value of products is retained for as long as possible. This approach requires not only a change in the way we design and manufacture products, but also how we use these products in our daily activities.

## 1.2 Purpose, Scope and Methodology

With the increasing consumer awareness on the problematic impacts of SUPs, there is a need for assessing alternative solutions that minimize the use of SUPs for applications in which they are not essential. Given consumer interest in making environmentally sound choices, efforts should be made to ensure that alternative options to SUPs are grounded on science-based sustainability information and that unintended outcomes are anticipated.

This report presents available data and estimates on the current consumption of single-use plastic items and their alternatives. Emphasis is given on packaging and materials used in food consumption, takeaway and delivery, namely food containers (for solid food), cups, plates, cutlery, straws, stirrers and bags. Both single-use non-plastic and multi-use alternatives are considered.

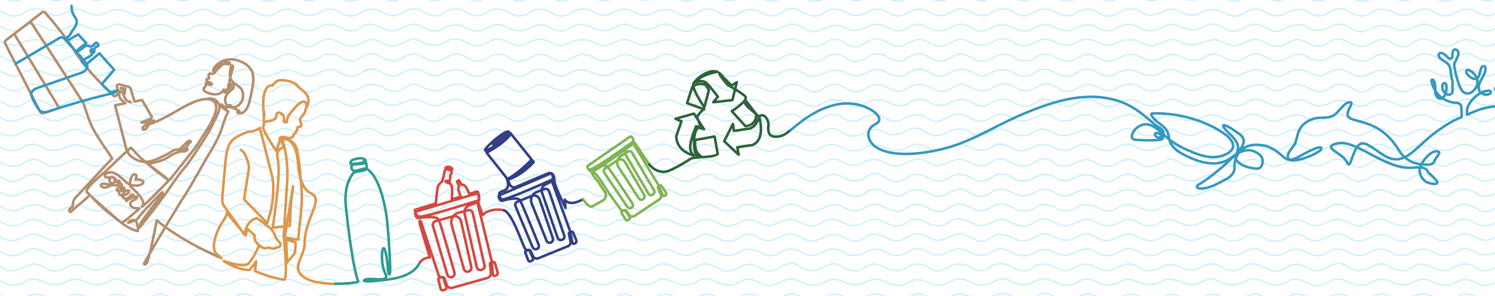
A cost per use data of SUPs and alternatives covered in this report was estimated to make the costs of multi-use alternatives comparable with single-use items. It should be noted that the costs reported reflect consumer price only and do not include externalities arising from the negative environmental and health impacts of the products listed. Service life data of SUPs and alternatives which are used in this report include various sources such as manufacturers of the products, internet publications and pertinent life cycle assessment (LCA) studies.

The report also provides a literature review and analysis of relevant data from life cycle inventories (LCI) or LCA meta-studies comparing different types of SUP items with alternatives that are currently available in the Philippines. LCA is a tool that is mainly used for comparing the environmental impacts of products by quantifying the potential environmental impacts throughout the product’s life cycle, i.e., from raw material extraction, production, use, waste treatment and final disposal.

LCA studies selected for review are those that tackle types of SUPs and alternatives that are commonly used or are available in the Philippines. Studies published from year 2010 to present were included, in consideration of the evolving technologies and changing practices, and those that have enough transparency to possibly access the underlying data and the detailed methodology used in the LCA.

The information in this scoping report is intended mainly for local use. In as much as studies from the Philippines and in the neighboring Southeast Asian countries could provide analysis that are more locally adapted or similar in context with the Philippine situation, there are only a limited number of relevant LCA studies found in these countries. Hence, studies from the European Union (EU) countries and the United States of America (USA) were covered in this review. Efforts of comparison of impact potentials between these different studies were approached with caution, with consideration to the differences with the Philippine setting. Nevertheless, this review still finds value from comparing the general conclusions across different LCA studies.

Overall, this report is intended towards providing information that can guide a more informed decision-making towards sustainable packaging solutions.



# 2. THE ECONOMY OF SUPs AND ITS ALTERNATIVES IN THE PHILIPPINES

## 2.1 SUP Consumption and Waste Generation in the Philippines

Based on the plastic material flow analysis of the Philippines conducted by Consortium Cyclos and AMH-MWTS for WWF Philippines shown in Figure 1, about 760,000 tons or 35% of the total plastic consumption is uncollected or leaked to the environment, while 33% goes to the landfill, 2% are used as alternative fuel for energy recovery, 9% are recycled and 5% of plastic wastes are exported (WWF Philippines, 2020).

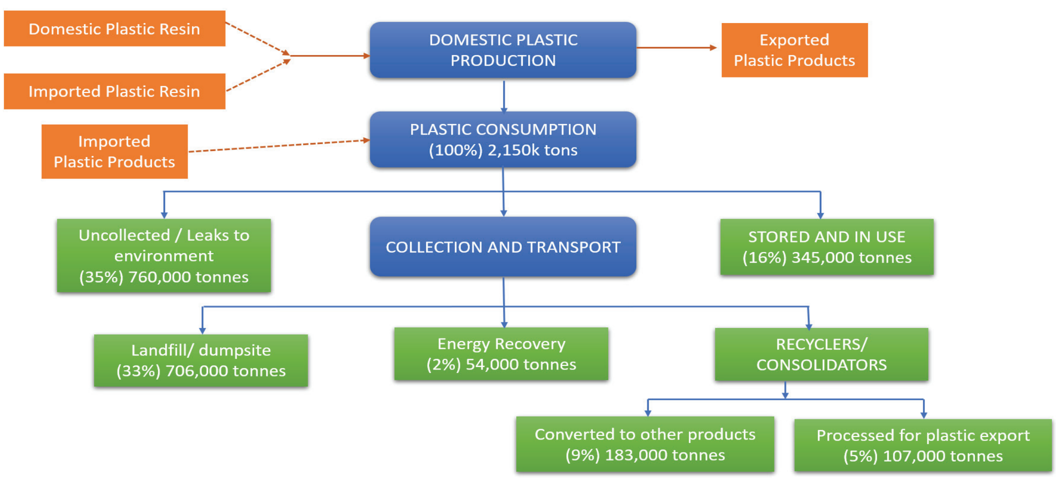



**Figure 1. Plastic Material Flow in the Philippines**

Figure 1, is generally applicable to Metro Manila and major urban cities such as those located in Regions 3 and 4. In other provinces in the country, the percentage of wastes that are uncollected and disposed to dumpsites can be higher due to the unavailability of recycling and energy recovery facilities, and sanitary landfills.

The data suggests that much of the plastic wastes are not utilized. Most are still uncollected, end up leaked in the soil or water bodies, which may eventually find their way into the ocean, or disposed in landfills or dumpsites.

Part of the strategies of the Philippine National Plan of Action for the Prevention, Reduction and Management of Marine Litter (NPOA-ML) is to establish a national baseline data on the leakage and impacts of marine litter from all waste sources in the Philippines. While the baseline study is yet to be implemented, the Ocean Conservancy's marine litter data from its International Coastal Cleanup (ICC) events in 2017 can provide insights on the extent of marine litter worldwide.

The numbers shown in the leftmost side of Figure 2 display the top 10 items collected worldwide, majority of which are food consumption items. Those conducted along Philippine coasts yielded similar results. From a total of 1,274 kilometers of coast and 214,165 volunteers, the top marine litter items found, by the count of number of items, were food wrappers (0.94 million), cigarette butts (0.35 million), other plastic bags (0.28 million), straws and stirrers (0.27 million), and plastic grocery bags (0.23 million).


**Figure 2. Top 10 items collected from ICCs worldwide and in the Philippines (Ocean Conservancy, 2018)**

## 2.2 Market Data on the Food Service Industry in the Philippines

The 2019 annual survey data from the Philippine Statistics Authority (PSA) shows that restaurants and mobile food service facilities accounts for 65.6% of the accommodation and food service activities sector in terms of number of establishments and net sales. Included in this market segment are restaurants, cafeterias, fast-food restaurants, pizza delivery, take-out eating places, mobile food carts and food preparation in market stalls (PSA, 2019).

Based on observation, this sector heavily consumes single-use plastic-coated paper cups and boxes, paper carrier bags, single-use plastic drinking straws and single-use plastic cutleries, especially for takeaway and delivery services.

Short-term accommodation services and event caterers, accounting for 29.7% and 1.7%, respectively, normally use multi-use tableware and beverage cups (e.g. glass, rigid plastics, ceramics, stainless steel). On the other hand, beverage serving activities comprise 2.8% of the market share of food service activities. Under this sector are bars, beer pubs and discotheques, which mainly use reusable cups, plates and cutleries, while coffee shops, fruit juice bars, milk tea shops and mobile beverage vendors rely heavily on single-use beverage cups.

Assumptions on the estimated usage of multi-use items and SUP items can be made based on the market share data for accommodation and food service activities sector. About one-third or 33% of the establishments mainly use multi-use items in their food service provision. Meanwhile, approximately 67% of the establishments use SUP items for food consumption, takeaway and delivery.

At the onset of the COVID-19 pandemic in March 2020, the already growing online food delivery services gained further preference as dine-in restrictions were imposed. Furthermore, dine-in restaurants who used to serve food with reusable cups, plates and cutleries shifted to offering takeaway and delivery services. Along with that, the use of single-use items for takeaway and food delivery also increased. Dine-in restaurants may revert back to using reusable food consumption items as economies start to open again in the country. However, the consumer's growing dependence on e-commerce will likely increase the usage of more SUPs, if the current convenience culture continues.

Detailed data on the local consumption of SUPs from the food service sector is not available. Nevertheless, local consumption estimates from available references are presented in Table 1. These estimates represent not only those utilized for food consumption, takeaway and delivery, but also include other non-food sectors.

**Table 1. SUP estimates in the Philippines**

| Single-use plastic criteria | Estimated amount | Base year | Data Source |
|---|---|---|---|
| Plastic carrier bags consumption | 17.5 billion pieces (pcs)/ year | 2019 | Global Alliance for Incinera-tor Alternatives (GAIA) |
| Plastic *labo* bags | 16.5 billion pcs/ year | 2019 | |
| Plastic packaging usage | 65.78 billion units/ year (forecasted) | 2018 | Statista |

On the other hand, bio-based plastics and biodegradable plastics are imported and not yet widely adapted in the Philippines. The volume of bio-based and biodegradable plastics produced worldwide is still small, with Asia accounting for over 46% of the global production in 2020. In 2019, the production capacity of bio-based and biodegradable plastics reported at 2.1 million tons represent about 1% of the total global plastics production (Alegado, et.al.2021).

## 2.3 Commonly used materials and available alternatives

Common types of single-use plastic packaging and items, and locally available multi-use alternatives and single-use non-plastic alternatives used for food consumption, take-away and delivery in the Philippines are discussed in this section.

### 1.1.1 Carrier bags

Carrier bags are used for takeaway food and delivery, and when buying fruits and vegetables from supermarkets and the public market. **Paper bags made of unbleached Kraft** are the most commonly-used single-use bags by restaurants and fast-food chains for takeaway food and delivery, especially in cities and municipalities where single-use plastic bags are banned or regulated. In public markets, grocery stores and sari-sari stores (a small neighborhood convenience store), **SUP bags made from low-density polyethylene (LDPE) or high-density polyethylene (HDPE)** are commonly provided. For small amounts of grocery items, **plastic labo bags**[1] are often provided in sari-sari stores and public markets at the point of sale.

**Bio-based plastic bags**, like conventional plastic bags are also designed for single-use only. Bio-based plastic bags are commonly made from bio-based raw material such as **polylactic acid (PLA), organic waste materials** such as sugarcane bagasse and crops such as corn. These bags are not always made from 100% renewable raw materials but are also used in composite with fossil-based plastics (Löw, et.al. 2021). Bio-based plastic bags are currently available as imported products in the Philippines.

**Biodegradable plastic bags** are also generally produced for single use and can be made from either bio-based or fossil-based raw materials. Typical bio-based raw materials for producing biodegradable plastic bags are starch, cellulose, carbohydrates, e.g. obtained from potato, cassava, etc. and PLA. While considered biodegradable and compostable, these are designed to biodegrade under specific conditions, not backyard compost bins or the environment (Löw, et.al. 2021).

**Oxo-degradable plastic bags** are likewise produced for single use only. They are made from

1 A thin, translucent plastic bag without handles that is made of HDPE or LDPE

conventional plastics such as PE to which additives are put in to accelerate breakdown into small pieces of plastics called microplastics, through the action of light, heat or oxygen. With the enactment of SUP bag bans in some local government units (LGUs) in the Philippines, producers switched to making oxo-degradable plastic bags around year 2008.

Reusable carrier bags that are made from **non-woven polypropylene (PP) or polyethylene terephthalate (PET)** are commonly termed as "*ecobags*" in the Philippines. These are usually available options at the cashier station in large supermarkets, for a fee of about Php 35. These can be reused by the consumers on their next buy. Woven **cotton bag** is another reusable alternative used by consumers.
**Native carrier bags or baskets** called **"bayong"** are traditional bags made from woven dried leaves of buri, palm leaves, pandan and abaca, all of which are native in the Philippines. These are traditionally used when buying goods from the local market.

### 1.1.2 Beverage cups

Most beverage cups used for takeaway drinks, gatherings or even for dine-in fast food restaurants are designed for single use. Take-away cups often come with plastic lids. Likewise, street vendors selling beverages also use disposable cups. Single-use cups are commonly littered in soil, canals, end up in the landfill or in the ocean.

**Single-use plastic beverage cups** commonly used in the country are made from **PP, polyethylene (PE) and PET. Polystyrene cups** used to be more common for serving hot drinks, but as LGUs started to ban polystyrene cups along with SUP bags, retailers began shifting to **single-use paper cups**. Paper cups are often coated with wax or PE lining, but these can also be coated with bio-based material such as PLA.

**Single-use bio-based beverage cups** are also available as imported items. These can be made from **PLA, sugarcane bagasse or corn** (Stuber-Rousselle, et.al. 2021).

**Reusable plastic cups**, commonly made from PP, HDPE and LDPE are designed for multiple uses. Other widely available reusable cups are made of **ceramic, glass, stainless steel** and **bamboo**. These are used in dine-in restaurants, eateries or as refillable cups for personal use. **Reusable silicone cups** are potential alternatives for a reuse network but these are currently bought for personal use, and not for commercial food service applications.

### 1.1.3 Takeaway food packaging

Takeaway food refers to the food that is sold for immediate consumption away from the food outlet after purchase. Takeaway food packaging is mostly single-use, but reusable ones are also provided. Different types of takeaway food packaging used today are commonly in the form of food boxes, clamshells and trays.

Commonly used **single-use plastic takeaway packaging** is made of **polystyrene (PS), PP and PET**. Disposable **bio-based plastic containers** made from renewable materials such as **PLA, sugarcane bagasse** and **cassava** are imported and less commonly used than SUPs. With the banning of takeaway packaging made of PS in some LGUs, food service providers had turned to using **paper coated with wax or PE lining**.

**Single-use multi-layer take-away packaging** is also available, which are made of layers of different materials such as **fossil-based plastics, bio-based plastics and aluminum**. A few food service providers offering takeaway and food delivery are using traditional means of packaging, such as **banana leaves, palm leaves** and **buri leaves**, as alternative food wrapper.

**Reusable food packaging** (with lids) made from **PP** have also become common for deliveries of to-share meals, especially those that contain sauce or soup. Reusable containers made from **silicone,**

**bamboo, stainless steel and glass** are potential alternatives, but these are normally bought by individuals for personal use, and not as takeaway food container from commercial food service providers.

### 1.1.4 Drinking straws

**Single-use plastic drinking straws** are the most commonly used for dine-in, takeaway and delivery. These are normally made from **PP**. Due to the increasing concern on the contribution of disposable straws to marine pollution and its impact on biodiversity, alternatives to single-use plastic straws have emerged.
One such alternative is **single-use biodegradable drinking straw**. These can be made from **PLA, sugarcane bagasse** or **rice flour**. Other multinational fast-food chains have also turned to **single-use paper straws**. As with other biodegradable alternatives to plastics, biodegradable drinking straws are designed to biodegrade under specific conditions at industrial composting facilities.

**Reusable** alternatives that are available in the market are made from **bamboo, stainless steel, glass** and **silicone.**

## 2.4 **Cost comparison of SUPs and its alternatives**

Cost is a major driver in deciding the material of choice for food consumption, takeaway and delivery, especially for businesses in the retail and food services sector. The National Solid Waste Management Commission (NSWMC) is mandated to update a list of Non-Environmentally Acceptable Products and Packaging Materials (NEAP) for phasing-out, in the condition that the NEAP alternatives cost no more than 10% of the cost of the NEAP and that the prohibition of NEAP is backed by science-based studies.

Table 2 presents a summary of the cost estimates of SUPs and its currently available alternatives in the Philippines. A cost per use column is added to make the costs of multi-use alternatives comparable with single-use items. It should be noted that the costs shown in Table 2 reflect consumer price and do not include externalities arising from the negative environmental and health impacts of the products listed.

**Table 2. Summary of Cost Estimates of SUPs and Its Available Alternatives in the Philippines**

| Material | Reference unit* | Cost/unit (PHP) | Estimated Service Life (no. of uses) | Cost/use (PHP/use) |
|---|---|---|---|---|
| **CARRIER BAGS** | | | | |
| ***Single-use*** | | | | |
| Plastic sando bags (LDPE, HDPE) - conventional | Mini - 16.5 x 8.5 x 33 cm<br>S - 20.5 x 10.5 x 36 cm<br>M - 25 x 12 x 45 cm<br>L - 30 x 15 x 45cm | 0.45 – 1.45 | 1 | **0.45 – 1.45** |
| Cassava-based | S - 14 x 35 cm<br>M - 25 x 40 cm<br>L - 33 x 40cm | 7.70 – 9.85 | q1 | **7.70 – 9.85** |

| Material | Reference unit* | Cost/unit (PHP) | Estimated Service Life (no. of uses) | Cost/use (PHP/use) |
|---|---|---|---|---|
| Kraft Paper | S - 22 x 10 x 30 cm<br>M – 25 x 8 x 36 cm<br>L - 28 x 13 x 39 cm<br>XL – 30 x 15.8 x 46 cm | 0.9 – 6.8 | 1 | **0.9 – 6.8** |
| ***Multi-use*** | | | | |
| Non-woven PP | 53 x 43 x 20 cm (thickness varies) | 35 – 100 | 50 | **0.7 – 2.0** |
| rPET | XS, S, M, L, XL | 2.70 – 5.00 | 50 | **0.05 - 1.00** |
| Abaca bags | 23 x 26 x 12 cm<br>25 x 25 x 16 cm<br>32 x 21 x 13 cm<br>37 x 17 x 27 cm | 109 - 178 | 50 | **2.18 – 3.56** |
| Cotton cloth bags | 16.5 x 21.5 cm<br>21.5 x 26.5 cm<br>25 x 30.5 cm<br>30.5 x 35.5 cm<br>34 x 40.5 cm | 38 - 88 | 50 - 150 | **0.25 – 1.76** |
| **BEVERAGE CUPS** | | | | |
| ***Single-use*** | | | | |
| Plastics (PP, PE, PET) | 240 ml | 0.78 – 2.40<br>(range: thin party cups to thicker milk tea cups) | 1 | **0.78 – 2.40** |
| Plastics (PS) | 240 ml | 1.40 | 1 | **1.40** |
| Sugarcane bagasse-based | 270 ml | 5.00 | 1 | **5.00** |
| Paper, lined with wax or PE | 240 ml | 1.56 | 1 | **1.56** |
| ***Multi-use*** | | | | |
| Reusable plastic (PP) | 240 ml | 16 | 25 - 35 | **0.64** |
| Glass | 350 ml | 100 – 250 (without cover and sleeves) | 2,500 | **0.04 – 0.10** |
| Glass | 350 ml | 218<br>(with silicone cover and sleeves) | 2,500 | **0.09** |
| Food-grade silicone (with lid) | 240 ml | 195 | Up to 3,000 times reuses | **0.065** |
| Bamboo | 250 ml | 120 – 150 | 365 | **0.33 – 0.41** |

| Material | Reference unit* | Cost/unit (PHP) | Estimated Service Life (no. of uses) | Cost/use (PHP/use) |
|---|---|---|---|---|
| Metal | 240 ml | 105 | 3,000 | **0.035** |
| Ceramics | 240 ml | 180-300 | 2,500 | **0.05 – 0.12** |
| Rice and/or Wheat Straw | 350 ml | 110.00 (with silicone cover and sleeves) | 365 | **0.30** |
| **TAKEAWAY PACKAGING** | | | | |
| ***Single-use*** | | | | |
| Plastic (PET,PP) | 1,760 ml | 1.30 - 2.00 | 1 | **1.30 - 2.00** |
| Plastic (PS) | 1,160 ml | 1.40 – 2.00 | 1 | **1.40 – 2.00** |
| Sugarcane bagasse-based | 1,815 ml | 14.00 | 1 | **14.00** |
| Kraft Paper coated with wax or PE | 500 ml | 3.6 | 1 | **3.6** |
| Aluminum | 1,760 ml | 12.00 – 14.00 | 1 | **12.00 - 14.00** |
| ***Multi-use*** | | | | |
| Reusable plastic (PP) | 1,350ml | 6.50 (thinner) | 25 - 35 | **0.18 - 0.26** |
| | 1,950 ml 32.00 (more rigid) | 600 | **0.05** | |
| Food-grade silicone | 1,200 ml | 228.00 | 3,000 | **0.08** |
| Glass | 1,040 mL | 194 | 2,500 | **0.08** |
| Bamboo fiber (with bamboo lid) | 1,248 ml | 250.00 | 365 | **0.68** |
| Rice and/or Wheat Straw | 1,900ml | 82.00 | 365 | **0.22** |
| Stainless steel | 1,605 ml | 399.00 | 3,000 | **0.13** |
| Ceramic | 900 ml | 886 | 2,500 | **0.35** |
| **DRINKING STRAWS** | | | | |
| ***Single-use*** | | | | |
| Plastic (PP) | 0.8 cm x 20 cm | 0.30 | 1 | **0.30** |
| Wheat | 0.8 cm x 20 cm | 1.20 | 1 | **1.20** |
| Paper | 0.6 cm x 21 cm | 0.8 - 1.56 | 1 | **0.8 - 1.56** |
| Rice flour-based | 0.8 cm x 20 cm | 2.02 | 1 | **2.02** |
| ***Multi-use*** | | | | |
| Glass | 0.8 cm x 20 cm | 20 – 70 (with 1 pc brush) | 2,500 | **0.008 – 0.03** |
| Bamboo | Small (for cocktail drinks) | 18 (with 1 pc brush) | 365 | **0.05** |
| Metal | 0.8 cm x 20 cm | 24 (with 1 pc brush) | 3,000 | **0.008** |

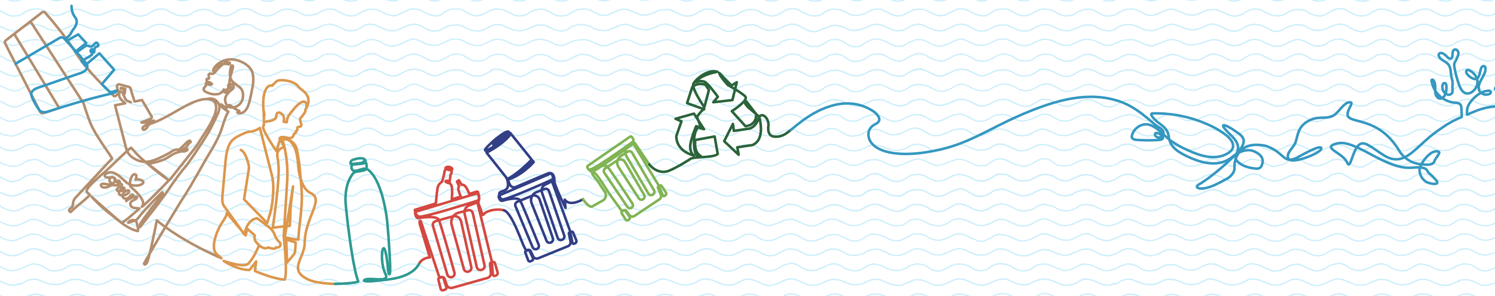
| Material | Reference unit* | | Cost/unit (PHP) | Estimated Service Life (no. of uses) | Cost/use (PHP/use) |
|---|---|---|---|---|---|
| Food grade silicon | 0.8 cm x 20 cm | | 65.00<br><br>(with 1 pc brush) | 3,000 | **0.02** |
| * S – Small<br><br>M – Medium<br><br>L – Large<br><br>XL – Extra large | cm – centimeter<br><br>ml - millimeter | | | | |

The reference units selected in Table 1 are those that can hold comparable amounts of food items or beverages. Equivalent reference units across the same type of application are selected as much as possible to make meaningful cost comparisons. Cost estimates were sourced from Lazada and Shopee, two of the major online selling platforms in the country, and directly from the websites of suppliers.

In general, single-use plastics for food consumption, takeaway and delivery are cheaper than other single-use options, particularly bio-based plastics and paper-made items. Multi-use alternatives have higher upfront costs because these are more durable and designed for multiple re-uses. However, if the reusable items are reused enough number of times within its service life, the cost per use becomes less expensive than single-use counterparts. This statement, however, does not consider additional costs associated with reusing the items such cost of water, detergent, energy and manpower during the cleaning or washing process.

Compared with SUPs, the estimated price per use of single-use bio-based materials like cassava, sugarcane bagasse or wheat cost 2 to 7 times more, which does not satisfy NSWMC's condition on NEAP alternatives. Bio-based and biodegradable plastics are relatively new technologies compared with conventional plastics, which have already an established economy of scale. This may change if bio-based materials become more mainstream in the future, as the production phase becomes more established and efficient.

In all cases, it should be noted that external costs of waste management and the negative environmental and health impacts of all items are not accounted for in the costs provided.



# 3. ADVANTAGES AND DISADVANTAGES OF SUPs AND THEIR ALTERNATIVES

## 3.1 Environmental Performance

This section discusses the environmental performance of SUPs and their alternatives using relevant and available LCA studies comparing different types of materials used for food consumption, takeaway and delivery.

### 1.1.2 Carrier Bags

***Single-use plastic bags as compared to reusable alternatives***

A comparison of the environmental performance of reusable carrier bags with single-use bags from various studies shows that reusable carrier bags have lower environmental impacts than single-use carrier bags. An LCA by Biona (2017) on carrier bags in Metro Manila compares single-use HDPE plastic bag with unbleached kraft paper bag and reusable non-woven PP. The study assumed that bulk of the fuel supply and process input materials is imported, based on the actual energy supply chain data of the country. The energy mix in the Philippines is dominated by coal (42%), followed by geothermal (24%), hydro (21%), natural gas (8%) and residual oil (6%). On the other hand, waste disposal scenarios in Metro Manila are assumed as 83-100% landfilled/ dumpsite disposal, 0% recycled, 4-12% buried in disposal pit, 5% thrown in waterways and 7-8% open burned.

The LCA study assumed that non-woven PP is reused at least 50 times. Results showed that **reusable non-woven PP performed best in eight (8) out of (9) impact categories** namely global warming potential (GWP), acidification, ozone depletion, human toxicity, eutrophication, photochemical ozone creation, ecotoxicity, flooding and landfill volume. In terms of fossil energy use, reusable non-woven PP falls in between single-use HDPE and paper bag.

A study of Civancik-Uslu et al. (2019) conducted in Spain and Denmark, introduced littering potential, which is not typically considered in LCAs, to compare SUP bags made from HDPE, paper, biodegradable plastics, and reusable bags made from LDPE and PP. Their study indicates that **single-use HDPE bag is almost 30 times worse than the reusable LDPE bag in terms of littering potential.** SUP bags, because of their light weight, tend to be more susceptible to littering than the reusable alternatives [9]. In view of about 35% or 760,000 tons of plastic wastes in the Philippines that are leaked to the environment, the lack of consideration of the impact of SUP littering in LCA studies undermines the environmental benefits of reusable bags.

The environmental advantage of reusable bags over conventional SUP bags is also exhibited in a study by Kimmel in 2014 under the USA and UK context, as reported by a meta-study conducted by the United Nations Environment Programme or UNEP (UNEP, 2020). Kimmel compared four SUP bags: a conventional HDPE bag, a partially recycled HDPE bag, a partially recycled paper bag and a 100% recycled paper bag, with two reusable bags, one made of LDPE and the other of non-woven PP. Results show that the reusable **LDPE bags needs to be reused about 6-9 times to be better than the partially recycled HDPE bag**, while the **reusable non-woven PP bag must be reused 13-20 times to have a lower environmental impact** than the SUPs studied.

Kimmel's study assumes that 40% of the SUP bags in the US and UK are reused second time as trash can liners. Most of these (82.2%) end up in the landfill after second use, while the rest (17.8%) is incinerated with energy recovery. One time reuse of SUP bags as trash liners is likewise practiced in the Philippines. Most of the plastic products consumed in the Philippines are leaked to the environment. Those collected are mostly landfilled or deposited in dumpsites. Compared with Kimmel's study, a smaller percentage of plastic wastes in the Philippines is recovered for energy.

This difference can cause a shift in the global warming potential of all plastic materials studied. Landfill disposal of plastic generally emits less greenhouse gases than incineration, except in cases where incineration is undertaken with high efficiency and high electricity to heat ratios (Eriksson and Finnveden, 2009). However, landfilling presents other significant risks such as the leaching of toxic chemicals into the environment. Furthermore, the study does not include littering in the end-of-life fate of plastic wastes due to methodological limitations. Littering of SUPs, which increases microplastics generation and susceptibility to flooding due to clogging of waterways, is a significant problem in the Philippines. Taking littering impacts into account in the LCA will cause an increase in ecotoxicity and human toxicity potential and adverse biodiversity impacts of SUPs.

LCA studies comparing reusable alternatives with SUPs show that in order to attain lower environmental impact, **the reuse rate needs to reach enough number of times for reusable alternatives to become environmentally better than the single-use bags** depending on the material (Stuber-Rousselle, et.al., 2021). For example, according to a UNEP (2020) study, a cotton bag needs to be used 50-150 times to have less climate change impact than a single-use plastic bag, while the Environmental Action Germany or DUH estimates that a cotton bag needs to be reused 25-32 times to be environmentally comparable to a single-use plastic bag.

In general, reusable alternatives tend to have greater environmental impacts than SUPs because a more durable material is used. However, once the reusable alternative is used sufficient number of times, the higher environmental impacts from higher resource production and consumption are compensated. Reusing avoids extracting new resources, avoids the use of utilities and materials, and generation of wastes and emissions from the production of new SUPs. Hence, it also reduces the amount of waste that has to be reprocessed, recycled and disposed at the end, and consequently prevents the associated health risks in all stages of the product life cycle.

***Conventional single-use plastic bags as compared to oxo-degradable plastic bags***

According to the International Biodegradable Polymers Association & Working Groups, European Bioplastics and UNEP, oxo-degradable plastics should not be considered an environmentally-friendly alternative to conventional plastic films because they do not result in better environmental outcomes and contribute to microplastic pollution (UNEP, 2018).

Results of LCA by Edwards et.al. in 2011 correspond with this position, where the authors indicated that the environmental difference between a conventional and a degradable HDPE bag is small, with the conventional HDPE bag a little bit better in all aspects (UNEP, 2020). The assumption in this study is that most of the carrier bags end up in landfills, which is valid in the Philippine context. The study also presumes that oxo-degradable HDPE bags do not degrade because of the lack of oxygen in the landfill environment.

Oxo-degradable bags disintegrate into microplastics faster than the conventional fossil-based plastic bags. Microplastics remain in the environment and cause environmental and health risks to marine life and humans. Furthermore, oxo-degradable plastic is not suitable for recycling and long-term reuse because the additives in such material rapidly reduces its mechanical strength (Aldas et.al, 2018).

***Single-use plastic bags as compared to single-use non-plastic alternatives***

LCA studies comparing single-use plastic bags with another single-use materials like bio-based plastics, paper and biodegradable bags suggests that no bag material is clearly preferable. This is because the impacts just shift from one category to another.

Ita-Nagy et al. (2020) analyzed a number of LCAs comparing bio-based and fossil-based plastics, and concluded that biobased plastics generally have a lower impact on climate change. However, their potentially lower carbon footprint due to the use of renewable resources, instead of fossil fuel, is accompanied by a trade-off for other impact categories such as acidification, eutrophication, particulate matter and photochemical ozone formation. These were exemplified by LCA studies conducted by Civancik-Uslu et al. in 2019, Edwards, et. al. in 2011, and the European Commission in 2019.

In the local context, the GWP for bio-based plastics may lead to higher climate impact compared with the non-Philippine studies mentioned, where the share of wastes incinerated at end of life is greater than in the Philippines. Due to poor waste segregation and the lack of infrastructure for composting in the country, biodegradable plastics are likely to end up in the landfill, dumpsite or leaked in the environment. Given that there are still open dumpsites and that not all sanitary landfills are equipped with methane utilization system, the release of methane in the landfill, dumpsite or those littered in soil can result to higher GWP.

A higher GWP also resulted in the Philippine study by Biona (2017) comparing single-use HDPE bag with unbleached kraft paper bag [10]. The LCA showed that paper bags performed worse in GWP, which is driven by the highly energy intensive raw material preparation and production of paper. Paper bags also contribute to higher eutrophication from the use of fertilizers during cultivation, higher ecotoxicological effects due to the use of biocides, and higher water resource depletion than single-use HDPE bag. On the other hand, the study showed that single-use paper bag contributes less to ozone depletion.

In terms of comparing end of life impacts, the European Commission concluded that recycling single-use LDPE bags will result in lesser GWP than sending biodegradable plastic bags to landfill or composting (Stuber-Rousselle, et.al, 2021). This is due to the fact that recycling LDPE leads to replacement of new fossil material, while biodegradable plastics only replaces fertilizers.

### 1.1.3 **Beverage cups**

***Single-use plastic cups as compared to single-use non-plastic alternatives***

From the meta-analysis conducted by UNEP (2021a) comparing the performance of single-use fossil-based plastic cups (PP, PS, PET, recycled PET or rPET), laminated paper cups (lined with plastic, PLA and wax), bio-based cups (PLA, plastics with PLA lining), shows that no material performed best or worst among the studied materials.

A meta-study conducted by UNEP for single-use beverage cups and their alternatives reported that despite the differences in context due to various factors such as cup weight, production process, allocation options and waste treatment, a study conducted by van der Harst and Potting in 2013 showed a common outcome that paper cups and PLA cups have lower GWP and abiotic depletion than a PS cup. On the other hand, a PS cup performs better in cumulative energy demand, acidification, eutrophication, photochemical oxidation, human toxicity, fresh water and marine aquatic eco-toxicity, terrestrial eco-toxicity, and ozone layer depletion (UNEP, 2021a).

Similarly, Changwichan and Gheewala showed in their LCA study in 2021 that under conditions in Thailand, that PLA cups have the lowest GWP and abiotic depletion among single-use PP and PET, but not in other impact categories. In terms of end-of-life scenarios, incineration of PET has the highest relative GWP compared with recycling of PET and PP, and anaerobic digestion, composting and recycling of PLA cups (UNEP, 2021a).

In the Philippines, collected wastes are still largely disposed in the landfills. This could significantly lower the GWP for single use fossil-based beverage cups relative to incineration, depending on the efficiency of the process and the electricity-to-heat ratios when it is replacing fossil fuels. However, landfilling can increase human toxicity due to toxic leachates. For PLA, a higher GWP will result from landfilling without methane recovery, in contrast to biodegradation through anaerobic digestion, composting or recycling. Furthermore, PLA and other bio-based alternatives to plastics are currently imported to the Philippines. Hence, the transportation from the country of origin to the Philippines may influence the results for GWP and abiotic depletion.

As discussed in previous sections, the lack of consideration on littering impacts in the LCA studies mentioned weakens the environmental disadvantages of SUPs. Similarly, single-use bio-based cups coated with plastics do not degrade readily in the environment, and hence could remain intact for a long time. Ingestion of plastic trash, products with plastics and microplastics can cause physical harm and death to marine animals. Most plastic products consumed in the Philippines are littered, in almost the same proportion as wastes ending up in landfills and dumpsites. Hence, littering impacts should not be undermined.

In terms of choice of lining material for paper cups, the UNEP (2021a) meta-analysis concluded that paper cups lined with plastic (PE) have lower impacts than paper lined with PLA, while paper cups coated with wax performed better than that lined with PE.

UNEP (2021a) meta-analysis also indicated that paper cups may be the least environmentally problematic among other single-use paper cups, especially if the currently low recycling rates can be turned around. However, in the case of the Philippines, laminated paper cups are normally landfilled rather than recycled, which will alter the degree of environmental impacts in the end-of-life treatment.

***Single-use cups as compared to reusable alternatives***

UNEP (2021a) reports that reusable cups have lower environmental impact than any other single-use alternatives, no matter the material. The same premise discussed regarding Figure 4 applies to reusable cups and other reusable items discussed in this report. However, this premise is highly dependent on consumer behavior as the number of reuses is important to reach a breakeven with disposable cups.

For instance, Almeida et.al in a 2018 study concluded that a glass or PP cup needs to be used 24 times to be environmentally better than a PE-lined paper cup and 10 times to be better than a PLA-lined paper cup (UNEP, 2021a). Changwichan and Gheewala in a 2020 study indicated that a stainless-steel cup washed by hand must be used 20, 40, and 70 times to have a lower GWP than a disposable PET, PP, or PLA cup, respectively (UNEP, 2021a). The reported number of reuses required to breakeven from these studies is well within the assumed life span of the reusable cups.

Aside from the reuse rate, the environmental advantage of reusable cups is also dependent on the efficiency of washing the cups. The LCA by Martin et. al. in 2018 showed that a ceramic mug washed in the dishwasher has the lowest impact than the hand-washed ceramic cup in all impact categories examined (UNEP, 2021a). On the other hand, a ceramic mug without lid washed by hand without hot water performed better than that washed by a dishwasher.

The results of the LCA will be influenced by the energy efficiency of the dishwasher, loading, water temperature and the source of electricity. Handwashing in ambient temperature water is the normal practice in the Philippines. Hence, less energy is used compared with the use of dishwasher and hot water. However, there could be a trade off in the water demand.

On the aspect of littering potential, reusable cups have lower littering potential than single-use cups due to their higher weight. Among reusable cups, the PP cup has an environmental advantage over the ceramic cup and therefore needs to be reused less often to be comparable to disposable cups (Stuber-Rousselle, 2021).

### 1.1.4 Takeaway food packaging

***Single-use packaging as compared to reusable alternatives***

LCA studies examined by UNEP (2021b) shows that reusable plastic take-away food packaging has a better overall environmental performance compared to single-use plastic packaging, as long as it is reused often enough.

The study by Gallego-Schmid et al. revealed that reusable PP meal box must be used 16 to 39 times to perform better than disposable extruded polystyrene (XPS) container in all impact categories, except for abiotic depletion, where the reusable PP container must be used 208 times to breakeven. Similarly, Baumann et.al. concluded that reusable PP container has lower GWP than the disposable PS container, assuming 360 times of reuse.

Aside from the reuse rate, the delivery system, the transportation mode and distance from the retailer to the consumer and back to the retailer, and the washing technologies and practices can influence the environmental performance of reusable food packaging. These factors are site-specific, hence, actual situations will vary across different locations.

***Single-use plastic packaging as compared to single-use non-plastic alternatives***

Based on UNEP (2021b) meta-study, XPS has a lower environmental impact than other single-use packaging materials such as PET, PLA, PP and aluminum mainly due to XPS's low weight per unit of food serving. XPS significantly use less energy and water compared with laminated paper and bio-based alternatives. However, its light weight also makes it prone to littering.

Despite the more favorable environmental performance of PS reported in these studies, the use of PS as takeaway food packaging in the Philippines has decreased after its banning by some LGUs. It is now replaced with laminated paper containers, which are commonly landfilled.

In an LCA comparing PS and sugarcane bagasse meal boxes in Thailand, Fangmokol and Gheewala (2020) concluded that sugarcane bagasse (bleached) packaging has higher environmental impacts than PS. The study suggested that the impacts of sugarcane bagasse box can be reduced if unbleached bagasse is used, and if the impact of microplastic pollution is taken into account.

The study also showed that PS has lesser GWP, eutrophication potential, ecotoxicity and human toxicity after end-of-life whether it is recycled, incinerated or landfilled, as compared with composting, incineration or landfilling of bagasse-based meal boxes.

Moreover, the currently less mature and smaller-scale production of bio-based packaging compared to the more established fossil-based plastic packaging is a disadvantage on an economy of scale perspective. There is potential that this may change positively in the future. In the Philippine context, the effect of importation of bio-based packaging to the impact categories, particularly GWP and abiotic depletion should also be taken into account.

In another study by UNEP (2021b), PLA packaging for take-away food performs better than PET packaging for most environmental impacts. The impact scores assumed that PLA will be recycled and composted. However, this is difficult to implement in the Philippines at the current infrastructure situation for recycling and composting. Hence, the disposal of PLA packaging in landfill without methane recovery or dumpsites will add to the global warming potential reported in this study due to the emission of methane.

### 1.1.5 Drinking straws

***Single-use plastic straws as compared to reusable alternatives***

Reusable alternatives to single-use drinking straws yielded lower environmental impacts, provided the reusable options are sufficiently re-used a number of times, that the use of hot water during washing is avoided and that the standard washing time is cut into half.

In particular, Chitaka et al. (2020) concluded that glass and steel straws would require 23–39 and 37–63 uses, respectively to break even with climate change emissions associated with disposable options (PP, PLA, paper). This study is conducted in the South African context, where coal was used as primary feedstock for the PP production. This makes the production more carbon intensive in comparison with PP produced from crude oil and natural gas as is the case in the Philippines. Hence, it is possible that lesser number of reuses of glass and steel straws are required to break even the GWP of disposable options.

However, the LCA study by Zanghelini et. al. (2020) concluded that plastic drinking straws have a better environmental performance than reusable straws examined (stainless steel, borosilicate glass and bamboo) in 10 out of 11 impact categories. The authors cited that the higher impacts were driven by the use of water and detergent during washing and the manufacturing of additional accessories like pouch and brush. Accounting for the impacts of marine litter may lead to a change in the environmentally-preferred option.

***Single-use plastic straws as compared to single-use non-plastic alternatives***

From the LCA studies gathered, there is no single-use straw option that is clearly environmentally preferable, due to the shifting of environmental burden from one impact category to another. Furthermore, some studies only focused on the climate impacts, while the scope in some studies did not include the raw material extraction phase such as the study by Moy and Tan (2021) which favored cornstarch-based bioplastic straw over paper straw.

Both Chitaka, et. al (2020) and thinkstep AG (2019) suggested that paper straw performs better than plastic straw made from PP in terms of GWP and abiotic depletion, which is in contrast to the conclusion of Rana (2020). Rana's study indicates that single use plastic straw has the least GWP and energy demand compared with paper straw and biodegradable straw.

In terms of littering potential and marine pollution impacts, the PP straw has higher impacts due to its light weight and the potential negative effects of microplastics pollution. Paper is associated with the least potential impacts in the disposal phase due to its biodegradability.

## 3.2 Comparison of environmental, economic and social aspects

Table 3 presents the main advantages and disadvantages that are associated with the use of single-use plastic items in food consumption, takeaway and delivery, and the adoption of single-use non-plastic and multi-use alternatives. The relative rating for upfront cost, local availability, food protection (applicable to food packaging/ containers), social and economic opportunities in rural areas and littering potential are assigned a value of low (L), medium (M) or high (H), based on qualitative assessment.

Food protection or preventing food waste by using packaging to extend the shelf life of food is included as an important criterion in considering the benefits and drawbacks of different food packaging products. The generation of food wastes has greater environmental impacts in view of a life cycle perspective than the environmental impacts of the packaging itself (Stuber-Rousselle, et.al. 2021).

## Table 3. Summary of Main Advantages and Disadvantages of SUPs and Their Alternatives

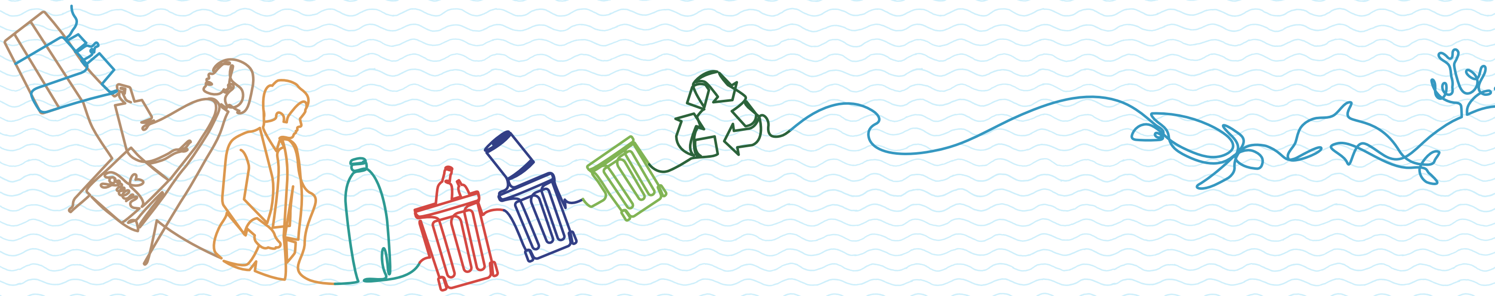
<table>
<tr><th>Product</th><th>Upfront product cost[a]</th><th>Local Availability</th><th>Food protection[b]</th><th>Social and economic opportunities in rural areas</th><th>Littering potential</th><th>Main environmental and social advantages</th><th>Main environmental and social disadvantages</th><th>Human health risk</th></tr>
<tr><td colspan="9">Single-use Products</td></tr>
<tr><td>Single-use plastic (fossil fuel-based) products</td><td>L</td><td>H</td><td>H</td><td>L</td><td>H</td><td>- Convenient for takeaway and fast-food applications</td><td>- Non-biodegradable<br>- Made from fossil fuel, a non-renewable resource</td><td>Risk of exposure to chemicals during production,<br>potential migration of chemical additives into food (Hahladakis et.el., 2018)</td></tr>
<tr><td>Bio-based plastic products from non-waste sources</td><td>H</td><td>L</td><td>M-L</td><td>H</td><td>H</td><td>- Utilizes renewable natural resources<br>- Compostable in an industrial facility or anaerobic digestion at end-of-life (Stuber-Rousselle, et.al, 2021)</td><td rowspan="3">- Compared with SUPs, can have higher environmental impacts associated with the production of the biomass due to land use changes, eutrophication from use of fertilizers and water resource depletion (Löw, et.al., 2021)<br>- Can cause sorting problems in the recycling process of fossil-based plastics, leading to quality degradation of the recycled material (Löw, et.al., 2021)<br>- Requires more research and development costs (UNEP, 2018)</td><td rowspan="3">- Risk from use of fertilizers and biocides (UNEP, 2018)<br>- Risk of contamination with heavy metals and trace elements that can be found from biomass source (UNEP, 2018)</td></tr>
<tr><td>Bio-based plastic products from agricultural/ food waste</td><td>H</td><td>L</td><td>M-L</td><td>H</td><td>H</td><td>- Utilizes renewable natural resources<br>- Compostable in an industrial facility or anaerobic digestion at end-of-life (Stuber-Rousselle, et.al, 2021)<br>- Reduces or avoids environmental impacts associated with production of crops<br>- Can help address food security issues associated with using bio-based materials that are also food crops</td></tr>
<tr><td>Biodegradable plastic products</td><td>H</td><td>L</td><td>M-L</td><td>H</td><td>H</td><td>- Utilizes renewable natural resources<br>- Compostable in a domestic composting, industrial facility or anaerobic digestion at end-of-life (depending on results of biodegradability tests) (Stuber-Rousselle, et.al, 2021)<br>- If used as food container, can be disposed of by composting or can be included in food waste (UNEP, 2021b)</td></tr>
</table>

| Product | Upfront product cost[a] | Local Avail-ability | Food protec-tion[b] | Social and eco-nomic oppor-tunities in rural areas | Lit-tering poten-tial | Main environmental and social advantages | Main environ-mental and social disadvantages | Human health risk |
|---|---|---|---|---|---|---|---|---|
| Paper and pa-per-based products (e.g. bags, cups, food container, drinking straws) | L | H | L | H | M | - Utilizes renewable natural resources<br>- Readily compostable | - Compared with SUP, can have higher environ-mental impacts associated with raw material extraction and produc-tion of paper due to land use chang-es (climate impact) and water resource depletion (Löw, et.al., 2021)<br>- Less durable than SUP coun-terpart | - Risk from use of fertiliz-ers and biocides (UNEP, 2018) |
| Pack-aging/ container made from native materials (e.g. buri, palm leaves, abaca, etc.) | M-L | Re-gion-de-pendent | L | H | L | - Utilizes renewable natural resource<br>- Compostable in domestic composting systems | - Less durable than SUP coun-terpart | - Risk from use of fertiliz-ers and biocides<br>- Risk of contam-ination with heavy metals, trace el-ements and pes-ticides |
| ***Multi-use Alternatives*** | | | | | | | | |

| Product | Upfront product cost[a] | Local Availability | Food protection[b] | Social and economic opportunities in rural areas | Littering potential | Main environmental and social advantages | Main environmental and social disadvantages | Human health risk |
|---|---|---|---|---|---|---|---|---|
| Multi-use alternatives (applicable to all multi-use materials listed below) | H | See individual products below | H | See individual products below | L | - May be used multiple times, thereby avoiding associated costs and environmental impacts of raw material extraction, production, use and disposal of single-use items<br>- Lower cost per use than single-use counterparts<br>- High potential to significantly reduce or eliminate need for single-use items | - Hygiene concerns can limit uptake of reusable alternatives (UNEP, 2021b)<br>- Higher initial cost can inhibit adoption<br>- Requires establishment of a circular business model that allows re-use system<br>- Additional labor and water consumption for washing<br>- Environmental advantage dependent on consumer behavior; have to be reused enough number of times depending on material to breakeven with environmental impacts of single-use counterparts ((Löw, et.al., 2021)<br>- Higher transport demands | See individual products below |
| Reusable plastic products | M-H | H | H | L | L | Lower water and energy consumption in production compared to bio-based products and other multi-use alternatives (UNEP, 2018) | - Non-biodegradable<br>- Made from fossil fuel, a non-renewable resource | Same risks with SUPs |
| Stainless steel products | H | H | H | L | L | | High energy consumption associated with production | Safe from leaching of chemicals when exposed to heat (Northrop, 2015) |

| Product | Upfront product cost[a] | Local Availability | Food protection[b] | Social and economic opportunities in rural areas | Littering potential | Main environmental and social advantages | Main environmental and social disadvantages | Human health risk |
|---|---|---|---|---|---|---|---|---|
| Ceramic products | H | H | H | L | L | | High energy consumption associated with production | Risk from leaching of lead (Pb) when exposed to heat (Mohamed, et.al.,1995, Shaundree, 2022) |
| Glass products | H | H | H | L | L | 100% recyclable and can be recycled infinitely (Glass Packaging Institute, 2022) | - Not impact resistant<br>- High energy consumption associated with production | Safe from leaching of chemicals when exposed to heat (Northrop, 2015) |
| Food-grade silicone products | H | L | H | L | L | Greater heat resistance than plastics | - High energy consumption associated with production<br>- Requires specialized recycling facility (Chung, 2019) | Fairly new to market, hence, few studies on its food safety. Available studies show that potential for migration is limited (Zhang, et.al, 2012) |
| Bamboo products | H | H | M-H | H | L | - Utilizes renewable resource<br>- Bamboo plant grows fast (UNCTAD,2022) and can easily be grown in the Philippines<br>- Avoids use of biocides during cultivation<br>- Biodegradable in the environment | - May require hot water washing for a more thorough cleaning | Safe from leaching of chemicals when exposed to heat |

a - external costs to society and the environment not considered
b – applies mainly to food packaging container
L – Low relative rating
M – Medium relative rating
H – High relative rating



# 4. CHALLENGES IN THE ADOPTION OF ALTERNATIVES

Alternative materials to SUPs can have significant role in reducing our dependence on SUPs. However, some challenges were recognized in the wider adoption of SUP alternatives, as discussed below.

**Influencing change in consumer behavior on adoption of multi-use alternatives**

Single-use items such as drinking cups and food boxes offer convenience at a low cost both for food outlets and the consumers. Using reusable items for food consumption entails additional washing and cleaning steps. Implementing take back schemes and refilling systems that make use of reusable food consumption items also demands effort on the part of the consumers. Furthermore, highlighted concern over hygiene during the Covid-19 pandemic has hindered efforts to address single-use plastic products and restrained the uptake of reusable alternatives.

**Sustainability issues from using biodegradable and bio-based alternatives**

Recent years have shown a growing interest in the development of biodegradable and bio-based alternatives to SUPs. However, arising issues on whether such materials are truly sustainable alternatives in the long term warrants further consideration as to its recommended adoption. The following concerns need to be considered:

- Confusion in the interpretation of terminologies like biodegradable, compostable, bio-based and bioplastics may convey the impression that these alternatives can be completely bio-degraded like other biodegradable wastes. This misconception, along with the inability to differentiate them from fossil-based plastics can lead to these alternatives being mixed with other biodegradables or recyclables, causing technical problems either in the composting of organic materials or in the recycling of plastics.
- If these biobased/ biodegradable/ compostable alternatives which are intended for single-use will be adopted, infrastructure such as industrial composting facilities need to be available, as well. Otherwise, its usage will bring forth the same disposal problems as with SUPs (e.g. unsegregated wastes, littering) if inappropriate waste management practices are not improved.
- Currently, the country lacks locally available testing facilities that are capable of verifying the biodegradation claims of these products. The Department of Science and Technology (DOST) is the only facility in the Philippines that is capable of doing overall migration test. Laboratory facilities for the biodegradability of bio-based plastics are not available.
- Biodegradable and bio-based alternatives have shorter shelf life than fossil-based SUPs which may cause storage problems and risk of microbial growth.
- For feedstock derived from food or grown of valuable cropland such as cassava or corn, food prices might increase due to competition.

### Burden shifting/ trade-offs

Every alternative material has potentially positive and negative environmental and social impacts. Shifting to alternatives might lead to solving one aspect of the product’s impacts but shifting the burden to another. Many factors can influence the choice of alternatives which makes it difficult to have one clear preferential option.

### Lack of financial and economic incentives or support for start-ups and small businesses

The Philippines is dominated by small and medium enterprises (SMEs) and often lack the start-up funding for establishing reuse systems and network. They also find it hard to fulfill eligibility criteria to avail of financial incentives and bank loans.
Similarly, local research institutions find it a challenge to transfer technologies on alternative packaging and plastic materials due to the lack of funding schemes that will support industry adoption while in the pilot phase.

### Negative economic impacts for SUP producers and SUP-dependent businesses

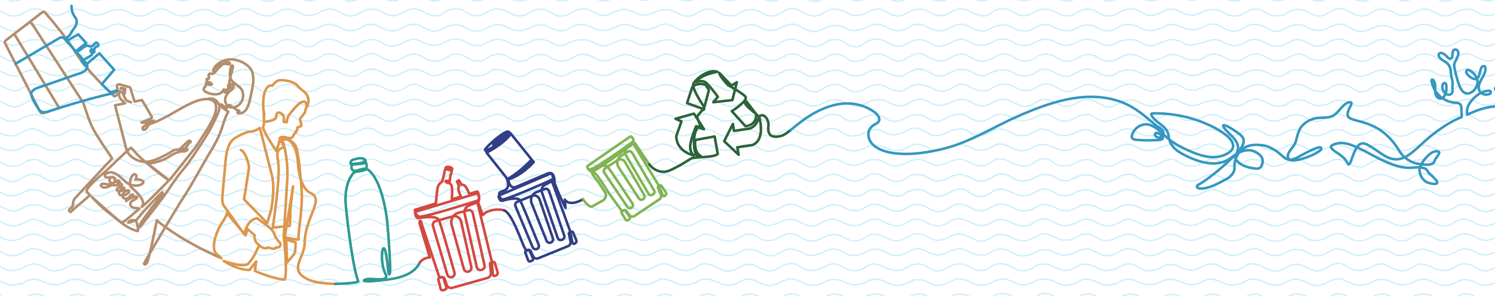
Calls to reduce and regulate SUPs in favor of the adoption of alternatives may create negative impact to plastic manufacturers, importers, retailers, plastic converters, brand owners, and food service providers using SUPs in the Philippines business-wise. There is currently no strong encouragement to shift to SUP alternatives both on the supply and demand side because SUPs still have cheaper upfront cost than the alternatives. This cost factor will have a greater proportionate impact on small-scale businesses.

However, if the House Bill (HB) No. 9147 or the “Single-Use Plastic Products Regulation Act” becomes a national law, certain “unnecessary” SUPs used in the food packaging, food delivery and takeaway such as drinking straws, stirrers, packaging bags that do not meet standard thickness, oxo-degradable plastics, cutlery and film wrap, will be banned.

The plastic producers’ sentiment is that all materials, not only plastic, have impacts. According to them, the problem is the way the plastic wastes are mismanaged, the absence of waste collection points and the lack of political will in the enforcement of Republic Act (RA) 9003 or the Ecological Solid Waste Management Act.

### Lack of enabling policies for plastics circularity

There is a lack of uniform implementation of the existing national policies on solid waste management and SUP-related regulations in the Philippines, resulting in inefficiencies and weak implementation. Furthermore, regulatory policies necessary to create an enabling environment for plastics circularity are still lacking. Voluntary commitments by the industry and the consumers yield positive results but these are not enough to significantly divert plastic wastes away from landfills and the open environment.



# 5. CONCLUSIONS AND RECOMMENDATIONS

The following are the main conclusions drawn in the preparation of this scoping report in view of providing informed decision making towards sustainable material solutions for the food consumption, takeaway and delivery:

- The order of preference for action to reduce and manage plastic waste should follow the waste management hierarchy (Figure 3). The top priority in managing plastic wastes should be prevention. Avoiding the use of the item in the first place is economically and ecologically the best way to reduce SUPs.

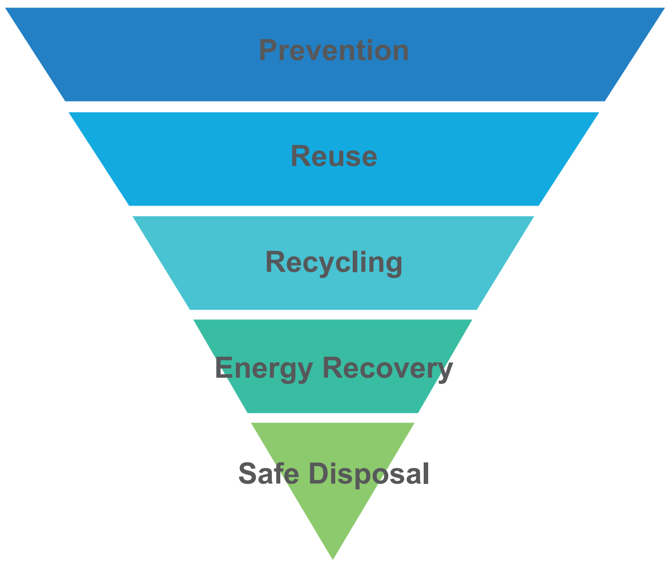



Figure 3. Waste Management Hierarchy

- The LCA studies presented in this report suggests that reusable products have lower environmental impact than single-use products, provided there is high reuse rate of durable and reusable plastic items. Using reusable products can help achieve prevention and reuse, the first two tiers of the waste management hierarchy. Using SUPs, on the other hand, will not fulfill the top tier. The same is true for single-use bio-based and biodegradable alternatives. The highest waste management level that can be achieved by SUPs and single-use alternatives, whatever the material, is the third tier, which is recycling.
- Simply replacing single-use fossil-based plastic products with another made of a different material (e.g. paper, oxo-degradable and biodegradable plastics) tends to simply shift the environmental impacts and create other problems (UNEP, 2021c). Consequently, substitution

will not lead to an overall better environmental benefit in view of the current problems with plastic waste management. Hence, policies directed to recommending alternatives should be carefully studied and should be grounded on evidence-based tools.

- How wastes are managed at the end-of-life phase (e.g. landfilled, littered in the environment, recycled, composted) have a significant influence on the environmental impacts of each product (UNEP, 2021c). Hence, the sustainability of products should be assessed considering the most feasible end-of-life option.
- While single-use plastics often appear as the cheapest option, it should be recognized that its "true" cost will often result in higher price once externalities are factored in such as the health and environmental impacts over the product's life cycle, ecosystem impacts, biodiversity impacts, cost of waste management, and the negative economic impacts in tourism and fisheries.

RA 9003 is the primary legislation in the Philippines that governs solid waste management. While the law provides the necessary policy framework and institutional mechanisms that are built around the principles of waste management hierarchy, it is weakly enforced and not fully implemented. This study aims to provide support to the government to help recognize what plans and programs that are in the existing laws need to be prioritized or reformed. It shall also reinforce the strategies laid out in the National Plan of Action for the Prevention, Reduction and Management of Marine Litter (NPOA-ML).

Key recommendations that policymakers should consider based on the conclusions and identified challenges in the adoption of alternatives to SUPs are provided below:

**Addressing SUP pollution through systems change**

The use of alternatives must be part of a broader strategy towards more sustainable production and consumption patterns, particularly for packaging and other single-use items. Addressing single-use plastic products requires systems change (UNEP, 2021c). It requires circular economy approaches across the life cycle of plastic products and its alternatives and a mix of policy interventions to reduce environmental impacts.

Multiple policy interventions that create an enabling environment for transitioning into a plastics circular economy needs to be implemented. Examples of these are bans or regulations on the production and use of certain SUPs, Extended Producer Responsibility (EPR) schemes, market-based instruments such as tax or levy on SUPs, encouraging circular business models, deposit refund schemes, subsidies supporting innovation, production and research efforts on alternative materials, education and awareness raising, and voluntary agreements/ initiatives by the industry and various stakeholders.

**Using life cycle thinking in policymaking**

Policies directed at recommending alternatives should be grounded on evidence-based tools. LCA and other appropriate tools that will include social considerations should be used to identify possible trade-offs, find ways to minimize them, and reduce burden-shifting. End of life scenarios should also be included in the LCA to assess which end-of-life options are most environmentally viable. Hence, there is a need to build more capacity on LCA and conduct more local context-based LCA studies to aid in policy decision making when identifying the best alternatives.

### Replacing single-use plastic products with reusable products

In view of the waste management hierarchy, the government should support, promote and incentivize actions that will extend the service life of products for as long as possible, by replacing single-use plastic products with reusable or multi-use products.

Encouraging the adoption of circular business models for alternative food packaging and delivery systems such as the purchase of products in refillable containers or reusable packs and take back mechanisms for reusable food packaging/ containers will help achieve wider use of reusable products.

In relation to the promotion of adoption of reusable products, national and local guidelines on food safety, in general should be followed by retailers and food establishments. This applies most especially to refillable food delivery systems and the use of reusable containers. Retailers and food service providers need to be transparent with the customers by informing them how they are following the safety protocols.

A review of development of new regulations pertaining to refilling initiatives by the Food and Drug Administration is recommended to support the adoption of new circular business models for alternative food packaging and delivery systems, leading to the reduction of SUP consumptions.

### Addressing sustainability issues from using biodegradable and bio-based alternatives

Plastic products from waste such as agricultural wastes should be preferred over bio-based materials that could be used as food in order to reduce potential conflicts with food production (Löw, et.al, 2021). Standards for the consistent labeling on plastic products, biodegradable and bio-based plastics should be mandated, including information on the post-use management and impacts of wastes so the public understands how to properly manage their wastes, and to facilitate proper sorting of wastes.

### Providing support for start-ups of SMEs

To support start-ups of SMEs for alternative materials and adopting circular business models, credit schemes for environmental technology promotion funded by public budgets or private foundations could be provided (GIZ, 2022). Financial support should also be provided not only for research and development projects on alternative materials, but should be extended to pilot testing of production by the industry, as well.

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**IMPRINT**

This publication was produced with support of the ‘Rethinking Plastics – Circular Economy Solutions to Marine Litter’ project. ‘Rethinking Plastics’ is funded by the European Union and the German Federal Ministry for Economic Cooperation and Development (BMZ) and implemented by GIZ and Expertise France. The contents of this publication are the sole responsibility of the author and do not necessarily reflect the views of the European Union, the BMZ, GIZ or Expertise France

**Project:**
Rethinking Plastics – Circular Economy Solutions to Marine Litter
https://beatplasticpollution.eu/rethinking-plastics/

**Author:** Angelica Celicious-Pelaez and Charlotte Jennifer Calonge (Delta Tierra Consultants, Inc.)

**Editors:** Mathias Gustavsson (IVL Swedish Environmental Research Institute) , Elena Rabbow, and Hyacinth Magat (GIZ)

**Design/ layout:** Flor Ian Louie Bantawig

**Photo credits/sources:** LuiChan Creatives



As of October 2022