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Substitutes for Single-Use Plastics in Sub-Saharan Africa and South Asia

Case Studies from Bangladesh, Kenya and Nigeria

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Acronyms and abbreviations

AfCFTA	African Continental Free Trade Area
BDT	Bangladeshi taka
CAGR	compound annual growth rate
EAC	East African Community
ECOWAS	Economic Community of West African States
EPR	extended producer responsibility
EPA	economic partnership agreement
EPS	expanded polystyrene
ESDO	Environment and Social Development Organization
FSC	Forest Stewardship Council
GSP	Generalized System of Preferences
Gt	gigatonne (billion tonnes)
HDPE	high-density polyethylene
HS	Harmonized System
ISO	International Organization for Standardization
K Sh	Kenyan shilling
LCA	life-cycle assessment
LCI	life-cycle inventory analysis
LCIA	life-cycle impact assessment
LDC	least developed country
LDPE	low-density polyethylene
MFN	most-favoured nation
Mt	megatonne (million tonnes)
NTB	non-tariff barrier
OECD	Organisation for Economic Co-operation and Development
PEFC	Programme for the Endorsement of Forest Certification
PET	polyethylene terephthalate
PLA	polylactic acid
POPs	persistent organic pollutants
PVC	polyvinyl chloride
RCA	revealed comparative advantage
RF	Rwandan franc
SACEP	South Asia Co-operative Environment Programme
SAFTA	South Asia Free Trade Agreement
SIDS	small island developing State
SMEP	Sustainable Manufacturing and Environmental Pollution
SUP	single-use plastic
UNDP	United Nations Development Plan
UNEP	United Nations Environment Programme
UNCRD	United Nations Centre for Regional Development
UNCTAD	United Nations Conference on Trade and Development
UNECA	United Nations Economic Commission for Africa
UNIDO	United Nations Industrial Development Organization
WTO	World Trade Organization

INTRODUCTION

This paper assesses the economic and technical feasibility of the production, deployment and scale-up of substitutes for single-use plastics (SUPs) in selected countries in sub-Saharan Africa and South Asia. A shift towards SUP substitutes could be one means of addressing the growing environmental and health challenges, including marine pollution, posed by the mismanagement of plastic waste in these regions. On the basis of this assessment and an evaluation of a range of potential substitute materials from a life-cycle perspective, the paper proposes specific plastic substitute options that could be considered for Bangladesh in South Asia and for Nigeria and Kenya in sub-Saharan Africa. These countries have been selected on the basis of a number of criteria including coastal locations, problems and challenges faced with regard to SUP pollution, a certain degree of manufacturing capacity, and both awareness of and initiatives to address plastic pollution among government and civil society groups. The potential for these countries to harness trade-related opportunities in these feedstocks and end-use products is also explored.

Chapter 1 examines environmental and health challenges arising from SUPs in sub-Saharan Africa and South Asia, highlighting particular examples from Sustainable Manufacturing and Environmental Pollution (SMEP)[1] target countries (UNCTAD, n.d.), including the paper's three focus countries: Bangladesh, Kenya and Nigeria[2]. It builds on and incorporates research and experiences developed under UNCTAD's Programme on Oceans Economy and Fisheries[3]. It identifies some problematic SUPs, on the basis of a global survey of beach litter in certain countries in South Asia and sub-Saharan Africa. It also reviews gaps and challenges related to waste management and recycling that heighten the SUP pollution problem in these countries.

Chapter 2 sets out and clarifies some key terms, definitions and concepts for SUPs and their substitutes – both polymer- and non-polymer-based materials. It also discusses issues related to standards and labelling practices with regard to packaging, including composition and end-of-life attributes.

Chapter 3 examines the reasons behind the widespread utilization of plastics for specific end uses. It also lays out a methodology for the identification of non-polymer-based natural feedstock materials that could be used to manufacture SUP replacements for specific end-use products in the three case-study countries.

Chapter 4 applies life-cycle assessment (LCA) tools to assess and compares the environmental sustainability performance of the various feedstock options identified in chapter 3. Information regarding sustainability performance was derived through the following tasks: a review of LCA studies; country-specific screening LCAs for grocery bags in Bangladesh, Kenya and Nigeria; and country-specific screening for all selected product categories in Nigeria, to assess their performance in multiple environmental impact categories.

Chapter 5 analyses the techno-economic dimension of the plastic substitute materials based on the LCA assessments of the three countries in chapter 4. The analysis aims to assess the availability of the identified feedstocks in the respective markets, the technical infrastructure and capability available to produce these products, and their economic viability.

Chapter 6 examines the trade flows and the trade policy landscape of all SMEP countries, and the South Asia and sub-Saharan Africa regions more broadly, for plastic as well as selected non-plastic feedstocks and end-use products. It discusses the potential for harnessing opportunities in trade. It also reviews the most-favoured nation (MFN) import duties applied to these products in the three case-study countries as well as prevalent duties applied in the context of selected bilateral and regional trade agreements.

Chapter 7 examines the domestic regulatory landscape to address prevalent SUPs in sub-Saharan Africa and South Asia, and notes key challenges and particular gaps that could be addressed.

Chapter 8 outlines broad conclusions and policy options based on the findings in this report. They address the following themes: (i) selecting the right SUP substitutes; (ii) building an effective ecosystem and enabling regulatory environment to address SUP pollution and encourage a circular economy; and (iii) enabling developing and least developed countries (LDCs) to tap into trade opportunities arising from enhanced manufacturing and production of plastic substitutes.

CHAPTER 1. DEFINITIONS AND CONCEPTUAL ISSUES

In any discussion of single-use plastics (SUPs) and their substitutes it is important to clarify terms and definitions so that the meaning and scope of what is being discussed are clear. Clarifying terms, concepts and definitions can also help alleviate confusion that exists in terms of consumer-driven initiatives to promote environmentally friendlier alternatives to SUPs, including through standards and product labelling. Doing so also helps guide understanding of issues related to identification and life-cycle-based screening of potential substitutes and the implications of trade and regulatory frameworks discussed in this report.

1.1. Single-use plastics

The UN Environment Programme (UNEP) uses this definition of SUPs: "Single-use plastics, often also referred to as disposable plastics, are commonly used for plastic packaging and include items intended to be used only once before they are thrown away or recycled" (UNEP, 2018a). SUPs include commonly used items such as grocery bags, food packaging, drink bottles, straws, containers, cups, plates and cutlery that are usually disposed of after one use (UNEP, 2018a). Establishments that commonly use them include fast-food and food takeaway and delivery outlets. Some of the main polymers used in the production of SUPs include polyethylene terephthalate (PET), polypropylene, low-density polyethylene (LDPE), high-density polyethylene (HDPE), polystyrene and expanded polystyrene (EPS) (Figure 1.1).

Figure 1.1. Main polymers used in the production of SUPs

PET	Bottles for water and other drinks	Dispensing containers for cleaning fluids	Biscuit trays	
PP	Microwave dishes	Ice cream tubs	Potato chip bags	Bottles caps
LDPE	Bags, trays, containers, food-packaging film			
HDPE	Milk bottles	Shampoo bottles	Ice cream containers	
PS	Cutlery, plates and cups			
EPS	Hot-drink cups, insulated food packaging, protective packaging for fragile items			

Source: UNEP (2018a).
Note: PET = polyethylene terephthalate, PP = polypropylene, LDPE = low-density polyethylene, HDPE = high-density polyethylene, PS = polystyrene, EPS = expanded polystyrene.

1.2. Biobased, biodegradable, compostable, oxo-degradable and recyclable plastic and non-plastic materials

The terms biobased, biodegradable, compostable, oxo-degradable and recyclable are often used in the context of plastics, although they can also describe properties, including those related to end-of-life of other materials including plastic substitutes. There are no internationally agreed definitions of these terms; UNEP has defined them for plastics as shown in Table 1.1. The term recyclable, for example, "is ambiguous and requires consideration of multiple aspects of packaging as well as local infrastructure and existence of end-markets for recycled material" (UNEP, 2018c). These definitions are important precedents and key building blocks for efforts to realize a United Nations treaty on plastic pollution and related marine litter.

Table 1.1. General description of SMEP target countries in 2019*

Term	Definition and context
Biobased plastics (also called bioplastics or plant-based plastics)	Plastics fully or partially produced from renewable feedstocks, such as corn, potatoes and sugarcane, or other biomass, rather than fossil fuels. The feedstock used to produce plastic is independent of its ability to be biodegraded or composted.
Biodegradable plastics	Biodegradable plastics are plastics that can be broken down by living organisms into elements that are found in nature, such as carbon dioxide or methane, water and biomass. When true biodegradation is complete, no microplastics remain. Biodegradable plastics can be manufactured from renewable feedstocks or fossil fuels. Soil-biodegradable plastics can be broken down by organisms found in soil. Marine-biodegradable plastics can be broken down by organisms found in seawater.
Compostable plastic	Compostable plastic is designed to biodegrade in a certain period of time under managed conditions, predominantly characterized by forced aeration and natural heat production resulting from the biological activity taking place inside the material. Compostable plastic biodegrades during composting but does not contribute to the value of the compost product, as it does not contain nutrients in its composition. Industrially compostable plastic requires conditions achieved only in industrial composting facilities (i.e. temperatures over 50°C) in order to biodegrade. Standards exist to specify the conditions and time required in order for a material to be labelled as compostable. Home- or backyard-compostable plastic is capable of breaking down at the soil temperature and conditions found in home compost piles.
Oxo-degradable (also called oxo-biodegradable or oxo-plastics)	Oxo-degradable plastics contain additives that cause them to break down under favourable conditions, most often ultraviolet radiation or heat. Oxo-degradable plastic fragments into smaller and smaller plastic particles but has not yet been shown to truly biodegrade, raising concerns that oxo-degradable plastics are a source of microplastics.
Recyclable	A packaging or packaging component is recyclable if its successful post-consumer collection, sorting and recycling is proven to work in practice and at scale.

Source: UNEP (2018c).

Note: The definition of recyclable was developed by the Ellen McArthur Foundation.

Recycling and composting are important elements of the circular economy and are influenced by a number of factors. Some of the key considerations based on which a product can be considered as well as labelled as recyclable include the following:

i. The type of plastic resin, with resins 1 (PET) and 2 (HDPE) being the most readily and economically recycled.

ii. The size, shape and colour requirements of plastics that are required to ease sorting in mechanical recycling and also, in many cases, are used for recognition by manual collectors as well.

iii. Liners, labels and components that make up the plastic products, their size, the materials they are composed of and whether they can be separated.

iv. Contamination of the product, whether through use of the wrong plastic type for a specific recycling stream (e.g. polypropylene in a PET recycling stream), different materials (e.g. paper or polylactic acid (PLA) in a PET recycling stream), food and beverage residues and other foreign material that can hinder product recyclability including through possible damage to machines.

v. The presence of additives such as persistent organic pollutants (POPs) that could negatively impact human health and the environment.

vi. The availability of recycling infrastructure in the location where the product is consumed.

vii. Economic end-markets for the recycled product, as "...if there is insufficient demand for a certain type of recycled material, then items made from that material cannot be considered recyclable" (UNEP, 2018c).

In addition, certain factors affect composability:

i. Infrastructure available for industrial composting which is "still limited globally although some municipalities have developed strong composting systems" (UNEP, 2018c).

ii. Organic waste separation, including separation of wet and dry waste, which can serve as a helpful foundation (in both infrastructure and behavioural norms) for the use of home-compostable and plastic materials that are soil-biodegradable (UNEP 2018c).

1.3. Standards and labelling

Before presenting an overview of standards and labelling initiatives as well as claims related to sustainability it is useful to clarify terminology (Box 1.1).

Box 1.1. Definitions: standard, certification, label, claim

Standard refers to specific criteria or norms of material goods or services, including packaging, which may also serve as benchmarks.

Certification refers to a formal accreditation process, in which it is confirmed that the certified entity or product or package meets a given set of (minimum) standards.

Label describes a logo or stamp highlighting a product or service's specific characteristic(s), which may also be used as a form of trademark. A label may or may not represent a certification.

Claim refers to assertions made by companies about beneficial qualities or characteristics of their goods and services.

Sources: UNEP (2018c); UN Environment and ITC (2017); OECD (2011).

a. Standards

Standards that are certified through an accreditation process, labelling and product claims are a useful means to harmonize production methods and communicate to consumers information regarding thresholds of quality, safety and other characteristics related to product and product packaging. Three main standard-setting bodies govern standards on sustainable packaging:

- The International Organization for Standardization (ISO) sets ISO standards.
- ASTM International sets ASTM standards.
- The European Committee for Standardization (CEN) sets EN standards.

In some cases, identical standards are set by more than one organization. For example, ASTM 6400 and EN 13432 are standards for biodegradability and compostability set by ASTM and CEN, respectively. Companies must pay to access the technical details of the standard and work with the certifying bodies to ensure compliance. No international standard specifies conditions for home composting of biodegradable plastics; however, several national standards do, such as NF T 51-800 in France. Table 1.2 compiles key standards for plastic packaging as well as some standards governing eco-labels in general.

Standards are often subject to limitations and may not respond to the realities of infrastructure capacity and to changes in technology. There may also be variations across standards and in how they are certified. For example, requirements and calculations for the share of recycled content in packaging may vary, as standards are implemented by different certifiers. The existence of a standard may not provide guidance on a product's overall sustainability and may be limited in its scope of application – for example, it may apply only to packaging. The overall sustainability of a product may depend on life-cycle impact calculations, which can be complex and costly and hence not usually provided to consumers (UNEP, 2018c).

Table 1.2. Selected standards for plastic packaging

Category	International standard
Recycled content	**ISO 14021** For Self-Declared Environmental Claims, including Recycled Content and Recycled Material This standard provides definitions for "recycled content" and "recycled material" that certifiers such as Scientific Certification Systems (SCS) and Underwriters Laboratory reference in their standards (SCS Global Services, 2014) (ISO, 2016)[a]. **EN 15343** Plastics. Recycled plastics. Plastics recycling traceability and assessment of conformity and recycled content. This standard aims to encourage proper recycling of plastics by standardizing it, particularly focusing on the process for tracing and assessing conformity and the recycled content of recycled plastics (Association Européenne des Recycleurs de Plastiques, 2019; CEN, 2007).[b]
Materials and recyclability	**ISO 18604** Material Recycling Introduced in 2012, this standard was intended to give guidance on which packaging can be classified as recoverable by material recycling and end the fragmented approach to recycling taken by jurisdictions, regulators, packaging manufacturers or certification bodies to date (Bell, 2013; ISO, 2013a)[c].

a ISO (2016), https://www.iso.org/standard/66652.html.

b CEN (2007), https://standards.cen.eu/dyn/www/f?p=204:110:0::::FSP_PROJECT,FSP_ORG_ID:22653,6230&cs=1BFF1149B3A2683C148F9FBC3CD0FD5D7.

c ISO (2013), https://www.iso.org/standard/55872.html.

Table 1.2. Selected standards for plastic packaging (cont.)

Compostable and biodegradable	These standards cover plastics and products made from plastics that are designed to be composted in municipal and industrial aerobic composting facilities: **ASTM D6400** Standard Specification for Labelling of Plastics Designed to be Aerobically Composted in Municipal or Industrial Facilities (ASTM International, 2019)[d], and/or **ASTM D6868** Standard Specification for Labelling of End Items that Incorporate Plastics and Polymers as Coatings or Additives with Paper and Other Substrates Designed to be Aerobically Composted in Municipal or Industrial Facilities (ASTM International, 2021b)[e] **ISO 18606** Packaging and the environment – Organic recycling (ISO, 2013b)[f] **EN 13432** Packaging. Requirements for packaging recoverable through composting and biodegradation (CEN, 2000)[g] **NF T 51-800 Plastics** These specifications, based on ISO 18606 and introduced in France, are for plastics suitable for home composting (ADEME, 2018)[h]. Home compostability is not currently addressed through international or European standards.
Biobased	**ASTM D6866** Test Methods for Determining the Biobased Content of Solid, Liquid and Gaseous Samples Using Radiocarbon Analysis (ASTM International, 2021a)[i]
General eco-labels	**ISO 14020** Environmental labels and declarations – General principles (ISO, 2000)[j] **ISO 14024** Environmental labels and declarations – Type I environmental labelling — Principles and procedures A Type 1 label is "a voluntary, multiple-criteria based, third-party programme that awards a licence that authorizes the use of environmental labels on products indicating overall environmental preferability of a product within a particular product category based on life cycle considerations" (ISO, 2018)[k]. **ISO 14025** Type III environmental declarations – Principles and procedures Type III environmental declarations are primarily intended for use in business-to-business communication, but their use in business-to-consumer communication under certain conditions is not precluded (ISO, 2006a)[l]

Sources: UNEP (2018c) ; SCS Global Services (2014); Association Européenne des Recycleurs de Plastiques (2019); Bell (2013); ASTM (2019); European Bioplastics (n.d.); ISO (2018); ISO (2019).

d ASTM International (2019), https://www.astm.org/Standards/D6400.htm.

e ASTM International (2021b), https://www.astm.org/Standards/D6868.htm.

f ISO (2013b), https://www.iso.org/standard/55874.html.

g CEN (2000), https://standards.cen.eu/dyn/www/f?p=204:110:0::::FSP_PROJECT,FSP_ORG_ID:13285,6242&cs=16419E079DF816FA31BA049B6F9169CF8.

h ADEME (2018), https://www.ademe.fr/sites/default/files/assets/documents/compostage-industriel-sacs-2018-rapport.pdf.

i ASTM (2021a), https://www.astm.org/Standards/D6866.htm.

j ISO (2000), https://www.iso.org/standard/34425.html.

k ISO (2018), https://www.iso.org/standard/72458.html.

l ISO (2006a), https://www.iso.org/standard/38131.html.

b. Product labels

Product labels, through their distinctive designs, are readily visible to consumers but can create confusion. Lack of clarity was one finding of a UNEP review of six types of labels on plastic products covering recycled content, biobased plastics, recycling guidance, recycling financing, compostability and degradability. Some biobased labels, for example, make a distinction between being made from "biomass" and "sustainably sourced biomass". There is also a need for clearer labelling to avoid consumer confusion between "biobased", "biodegradable" and "compostable", including to avoid contamination of waste streams.

Many bioplastic products require industrial composting, for which most countries lack adequate facilities. Plastic alternatives that are biodegradable and compostable may not be favoured from an overall environmental life-cycle perspective (chapter IV), yet several factors may make them preferable for developing countries, at least in the short to medium term. In addition to a lack of waste management and recycling facilities, these factors include favourable end-of-life impacts, and widespread reuse and take-back schemes (and their economic benefits for rural communities). Eventually, types of compostable and biodegradable plastic packaging that are environmentally friendlier over the life cycle may be developed.

c. Claims

Claims can provide information about the content of plastic packaging or foodware (e.g. made from recycled, biobased or ocean plastic) as well as how to use or dispose of the plastic (e.g. compostable, biodegradable or recyclable). Claims made on products and product packaging are less credible than labels when not backed by certification. Claims may also fail to provide the full picture: for example, how to dispose of a biobased plastic bottle (which may need industrial composting). These inadequacies increase the risk of careless disposal by consumers, adding to pollution streams. Products that claim 100 per cent compostability or biodegradability may not specify how to carry out the composting. In many countries, the lack of industrial composting facilities means that in practice such products may not be biodegradable or compostable. Similarly, it is important to distinguish between the terms "made from recycled plastic" and "recyclable". UNEP (2018c, p. 54) points out that "While the former refers to the content of the packaging, the latter gives guidance on how consumers can dispose of a product. If a packaging includes both types of claims, it is best to place them in close proximity to improve clarity and avoid confusion".

For developing countries that seek to promote fully home-compostable plastic substitutes, it may be argued that claims that are regulated by laws in producing countries and import markets could be a more economical solution than certification and labelling, particularly for small producers. For fully reusable and recyclable materials such as glass and aluminium, end-of-life claims and overly complicated certification can be avoided, whereas for biobased or biodegradable plastic materials they may be necessary.

Nevertheless, simple product claims that are regulated by governments and consumer protection agencies could be considered. Such claims can attest to both product composition (for example, made from natural or biobased materials without addition of polymers and chemicals) and methods for end-of-life disposal (for example, "Please compost at home" or "Please recycle" instructions). Simple and clearly written claims can more effectively educate consumers, who may not understand the complexities of labelling schemes. In addition, well-regulated claims that vouch for certain production aspects (such as "made from sustainable forestry plantations", "made from agricultural waste by-product" or "produced using 100 percent renewable energy sources") can convey important information about product life-cycle sustainability without costly certification. However, if countries wish to export such products regionally or internationally, some form of harmonization or mutual recognition of product claims and labels may be required, as well as application of international standards, testing and additional certification. Arguably, one advantage of products made from natural materials or from simple materials such as glass and aluminium is that their compostability or recyclability is globally recognized, irrespective of labelling or certification.

CHAPTER 2. THE PROBLEM OF SUPS IN SMEP TARGET COUNTRIES

2.1. Adverse impacts of plastics production and waste mismanagement

Negative health impacts on the human body start from the air pollution one inhales to the water one drinks and the soil used to grow crops that one eats. Manufacturing production without environmental control can cause these health impacts. For example, tannery effluent contains large amounts of pollutants, such as salt, lime sludge, sulphides, and acids. The tanning process stabilises the collagen or protein fibres in skins so that they stop biodegrading — otherwise, the leather would rot right in the closet. People who work and live near tanneries can suffer exposure to toxic chemicals used to process and dye the leather. Arsenic, a common tannery chemical, has long been associated with lung cancer in workers exposed to it regularly. Studies of leather-tannery workers in Sweden and Italy found cancer risks between 20-50 per cent above those expected (Mikoczy and Hagmar, 2005).

Plastic pollution has become a global crisis requiring urgent attention. Rapid growth in plastics production, trade and consumption since 1950, combined with the lack of proper waste collection, recycling and disposal, has caused widespread plastic pollution, especially in the oceans. Plastic debris has been found in all major ocean basins. "Plastic waste is now so ubiquitous in the environment," note Geyer et al. (2017), "that it has been suggested as a geological indicator of the Anthropocene era".

Plastics have become the fastest-growing material produced in the world and are expected to account for 20 per cent of the world's oil consumption by 2050 (UNEP, 2018a). SUPs, also referred to as disposable plastics, have become the norm rather than the exception for packaging products around the world. Packaging that traditionally was not made from plastic materials has been replaced more and more by SUP products: to name a few, glass bottles for milk and water have been replaced with plastic bottles and sachets, paper wrappers have been replaced with plastic film and jute sacks have been replaced with plastic bags. Plastic waste in developing countries is a combination of imported plastic products, packaging and plastic waste as well as plastic produced domestically.

With the meteoric rise in plastic consumption, numerous sustainability challenges have emerged. Conventional plastic is oil based; thus its production contributes to the greenhouse gas emissions responsible for climate change. The end-of-life phase of SUPs poses a pressing environmental challenge as fossil fuel-based plastics do not easily decompose when discarded. Depending on the type of feedstock, plastic may never fully decompose, decades or even centuries after later. Instead, over time, it disintegrates into smaller pieces and ceases to be visible. But the disintegration creates microplastic or nanoplastic particles now known to have penetrated the food cycle and made their way into human and animal bodies worldwide, with greatly adverse consequences on human and animal health (Yee et al., 2021).

In 2015, about 388 million tonnes (megatonnes, or Mt) of plastics were produced, of which 99.5 per cent were fossil fuel-based (UNEP, 2018d). A recent study estimated that 11 Mt of plastic waste entered the oceans in 2016 (Pew Charitable Trusts and SYSTEMIQ, 2020). Such pollution occurs mainly as a result of poor waste management, littering and overconsumption (Jambeck et al., 2015). Although estimates of the volume vary, it is manifestly clear that too much plastic waste enters rivers, seas and oceans, which have turned into the world's biggest "landfill", causing environmental, economic and social damage.

Even before reaching the sea, mismanaged plastic waste – i.e. discarded or littered items that do not end up in proper waste management or treatment facilities – has significant impacts on human health. The issue requires urgent attention, as highlighted by mounting international concern. In March 2019, the United Nations Environment Assembly adopted resolutions calling for action by governments, businesses and relevant stakeholders to address plastic pollution and significantly reduce SUP use by 2030 (UNEP, 2019a).

A large number of developing countries figure prominently among countries with the highest volumes of mismanaged plastic waste generated by coastal populations. In 2020, for example, Egypt, Nigeria, South Africa, Algeria and Morocco were among the top 20 countries contributing to marine plastic debris. Using the best country-level data available, total mismanaged plastic waste for the continent in 2010 was estimated at 4.4 Mt, out of 32 Mt mismanaged globally (Jambeck et al., 2018). The total is projected to grow as high as 10.5 Mt by 2025 if no additional action is taken to deliberately reduce the flow of land-based plastics to the ocean (Jambeck et al., 2018). In South Asia, the region's contribution to global plastic waste has been estimated at roughly 11 per cent per year since 2016, or 26.72 Mt of plastic waste every year (Kapinga and Chung, 2020). India and Bangladesh also figure among the top 20 countries with the highest volumes of mismanaged plastic waste generated by coastal populations (Law et al., 2020).

Mismanagement starts with disposal methods. As of 2016, out of 220 Mt of plastic waste generated, 41 percent is mismanaged. Of the 59 percent that is managed, landfilling is the most common method of disposal, followed by recycling and incineration (Pew Charitable Trusts and SYSTEMIQ, 2020). If demand for plastics continues to grow as projected, and the share of plastics incinerated displaces the share of waste landfilled, estimates are that total emissions from both the process of producing plastics and the carbon embedded in plastics could reach 287 billion tonnes (gigatonnes, or Gt) by 2100. That would equate to more than 33 per cent of the carbon budget projected as necessary to achieve a 2°C economy by 2100 – a goal of the Paris Agreement (Deere Birkbeck and Sugathan, 2021; Material Economics, 2018)[4].

Understanding of additives used in plastics and for waste disposal and regulations on their use is weak in many developing countries. In Africa, most plastic waste disposed of with municipal solid waste, with minimal formal recycling (approximately 10 per cent). There is also little or no thermal or energy recovery from waste plastic or other wastes. Consequently, most plastic ends up in dump sites or waterways or disposed of through open-air burning. The type of waste may also broadly reflect consumption patterns. Data on municipal waste stream components in Africa are not available. An analysis of plastic components of municipal waste in Bangkok, Thailand, may give an indication of what might be found for developing countries in Africa. The analysis found that plastic component waste contained HDPE (57.4 per cent), LDPE used for plastic carry bags (a major source of SUP pollution) (17.4 per cent), polypropylene (7.3 per cent) and PET (5.9 per cent). Polystyrene, polyvinyl chloride (PVC) and other components represented 4.8 per cent, 2.2 per cent and 5 per cent. These data and are roughly in line with the major import codes in the Harmonized System (HS) used in Africa (Babayemi et al., 2019).

In much of South Asia, plastic waste is disposed of by open dumping (75 per cent), sanitary recycling (16 per cent) and landfilling (4 per cent). Only about 5 per cent of plastic waste is recycled. Two factors amplify the challenge of waste disposal: the limited space available for landfills given the general population density (as well as actual space limitations in small island developing States (SIDS), such as Maldives) and the environmental debate about incineration, which releases noxious gases such as dioxins and furans into the atmosphere[5]. According to one estimate, the rivers Indus, Meghna, Brahmaputra and Ganges account for roughly 22 per cent of the volume in the 10 most plastic-polluted rivers worldwide, which equates to approximately 19 per cent of marine plastic pollution worldwide. This has negative implications not only for marine life but also for human health through microplastic ingestion along the food chain, as well as for industries such as tourism that depend on clean beaches and surroundings (Kapinga and Chung, 2020).

Improper disposal of plastic imposes environmental, economic and social costs. Because of the short first-use cycle and lack of circularity of plastic, each year the global economy is estimated to lose 95 per cent of plastic packaging material, valued at $80–120 billion. Meanwhile, 32 per cent of plastic packaging escapes collection systems. This generates significant economic costs by reducing the productivity of vital natural systems such as rivers and oceans and clogging urban infrastructure such as drainage systems, which leads to flooding during periods of high rainfall (Ellen MacArthur Foundation, 2016). In Bangladesh, for example, the floods of 1988 submerged 55 per cent of the country's land area and affected 45 million people resulting in over 2,000 deaths. They were found to have been exacerbated by plastic-bag litter that blocked city drains (Kapinga and Chung, 2020). Similarly, floods in 2001 in Accra, Ghana, damaged 17,000 homes and led to 100 cholera deaths; they were caused by blocked waterways (Amoako and Frimpong Boamah, 2015). In developing countries, studies have found that up to a third of cattle and half of goats have consumed significant amounts of plastic, causing suffering for animals as well as economically affecting farmers who own grazing livestock (Tearfund et al., 2019). As in many cities in South Asia, open-air burning of plastic is common in big cities in Africa such as Ibadan, Lagos, Kaduna and Kano in Nigeria, resulting in smog and poor air quality (Kehinde et al., 2020).

2.2. Relevance of domestic production versus plastic imports

Babayemi et al. (2019) estimated that 33 African countries imported approximately 86 Mt of polymers in primary form and 32 Mt of plastic products between 1990 and 2017. Extrapolating to the continental level (for a population of 1.216 billion in 54 countries), one can estimate that about 172 Mt of polymer and plastic products were imported in that period. In addition, plastic components (embedded as part of larger products) estimated at 230 Mt by volume entered Africa in this period[6]. Table 2.1 shows the six countries with the largest shares in terms of volume as well as shares of plastic components imported. Actual import figures may be much higher, as the numbers here do not include embedded plastics in products such as automobiles. These six countries accounted for about 75 per cent (approximately 88 Mt) of the polymers and plastics consumed in the 33 African countries reviewed by Babayemi et al. (2019).

Table 2.1. Leading importers of plastic components in Africa, 1990–2017

Country	Volume imported (Mt)	Share of total (230 Mt) (%)
Egypt	43	18.7
Nigeria	39	17.0
South Africa	27	11.7
Algeria	26	11.3
Morocco	22	9.6
Tunisia	16	7.0

Source: Adapted from Babayemi et al. (2019).

As regards domestic production, eight African countries – Algeria, Egypt, Ghana, Kenya, Morocco, Nigeria, South Africa and Tunisia – produced 15 Mt of primary plastics from 2009 to 2015. These plastic-producing countries exported approximately 5 Mt of primary plastics. Degrees of import dependence differed. For example, in Egypt and Nigeria, 70 per cent of plastics consumed both in primary form and as products were imported. In contrast, South Africa imported only 27 per cent of primary plastics and exported 24 per cent of locally produced plastic resins and products (Babayemi et al., 2019).

In South Asia, the production of plastics is estimated at 17–20 Mt annually, with reports of increased investment by producers leading to further expected growth in output. Plastics production in Bangladesh, for instance, has seen a stunning growth rate of 20 per cent since the 1990s. According to the World Bank, India alone was expected to produce 20 Mt of plastics in 2020. Overall, the region is a net importer of plastics. India is the only South Asian country that is a net exporter of processed plastic products, mainly to East Asian countries and to Europe (Kapinga and Chung, 2020). Although Bangladesh is a net importer, plastic products are an emerging industry. Bangladeshi producers, while focusing primarily on the domestic market, have recently started exporting certain low-end plastic products, mainly to Canada, China, European Union countries, the United Kingdom and the United States. Previously the focus of exports was also on PVC bags and plastic waste; however, the latter has been affected by the 2018 Chinese ban on plastic waste imports, a shift which increases the risk of plastic pollution within Bangladesh. In addition, about 0.4 Mt of plastic raw materials are imported into Bangladesh annually, of which 20 per cent goes into plastic packaging (Rehman, 2020). In terms of magnitude, the volume of global trade in plastic packaging (14 Mt) is significantly smaller than the volume in other categories such as primary plastics (196 Mt). Nevertheless, it is a high-value sector, with the total value of exports reaching $53 billion in 2018 (5 per cent of total plastics trade). Such products are typically single use (Deere Birkbeck and Sugathan, 2021).

The trends discussed here imply that regulations and strategies to identify and deploy substitutes for plastics, including SUPs, need to consider domestic production as well as exports and imports.

2.3. Problematic SUP pollution sources and plastic types

The health-care sector is a major source of SUP pollution. An analysis carried out by Circle Economy (n.d.) in the Netherlands of disposable plastic packaging used in health care – which makes up more than 50 per cent of the plastic waste generated by the sector – revealed that by weight, the largest estimated volumes of plastic types are polypropylene, followed by PET, mixed HDPE with coated medical-grade paper and PVC. Of these materials, PET and HDPE are the most recyclable, as they are the most commonly used and recycled plastics in places where recycling takes place. Although LDPE, polypropylene and PVC are also recyclable, they are usually not recycled but rather downcycled (transformed into materials of lower quality). Mixtures of plastics and other materials such as paper cannot be recycled so they typically are disposed of or incinerated (Circle Economy, n.d.). Often plastics that could be recycled are not clearly marked or are not identifiable by type of polymer.

In addition to SUP packaging, the fast-moving consumer goods segment is a major source of SUP pollution in both South Asia and Africa. In Nigeria, an audit of plastic waste materials in Lagos revealed that the materials gathered were mostly food packaging and that 94 per cent were actually recyclable PET. Containers such as plastic water bottles and sachets used for packaging beverages and water were highly implicated in coastal and marine pollution. A number of the pollutants were from major multinational brands (IPEN News, 2019). In many African countries, sachet water industries also consume a large share of polyethylene (both LDPE and HDPE). In Nigeria, for example, Lagos alone has more than 1,500 sachet water factories and about 60 million sachets being consumed daily. This plastic waste in particular is often disposed of by littering or in drainages. Although deposit schemes could be a practical option for addressing sachet waste, such schemes are very rare in Africa (Babayemi et al., 2019). Plastic water sachets and similar fast-moving consumer goods such as food packaging could be ideal candidates for exploring the use of substitute materials.

In South Asia, as in sub-Saharan Africa, there is a lack of comprehensive and systematic data on the various sources of SUP pollution. However, polythene bags and certain types of SUP have been identified as particularly problematic worldwide. The SUP types include food wrappings, cigarette butts – which are mainly made of cellulose acetate, a bioplastic (Root, 2019) – plastic bottles, caps and lids, cups, plates and straws (UNEP and GRID-Arendal, 2016). A 2019 survey on SUPs carried out by the Environment and Social Development Organization (ESDO) in Bangladesh estimated that citizens throw away 87,000 tonnes of SUPs every year. About 96 per cent is packaging for food and personal care products, and about 35 per cent is sachets – which are completely non-recyclable and non-biodegradable. Most SUPs are not properly disposed of and end up in landfills, rivers and oceans. The survey found that airlines, high-end residential hotels, restaurants and supermarkets were significant sources of SUP waste. It indicated that restaurants in the country used over 2,000 tonnes of SUPs every year, with airlines contributing an additional 685 tonnes and high-end residential hotels another 638 tonnes (ESDO, 2019).

A recent report by Ocean Conservancy on its global annual beach clean-up includes a compendium of collected items, tabulated by country and type and published online[7]. The overall findings for selected countries in sub-Saharan Africa and South Asia, focused on litter found on beaches rather than in waterways or on land, are summarized in Table 2.2 They can be considered illustrative of the problematic plastic types found in both regions. Given that the percentages are based on a one-time collection exercise they should not be taken as definitive, but they can be considered fairly representative of the sources of the major types of beach and marine pollution in these countries.

Among the top 10 plastic categories collected in the global clean-up there are some interesting variations among the selected countries in sub-Saharan Africa and South Asia. Plastic beverage bottles are clearly a problematic item: they are the largest category by volume in four countries reviewed in Table 2.2, in India, Maldives and Sri Lanka and in Kenya, and the second largest category in Nigeria. Food wrappers are the largest by volume among plastic categories collected in Nigeria and the second largest in Senegal and South Africa, and in Bangladesh, India and Maldives. Cigarette butts are the largest by volume in Bangladesh and South Africa. This last category is particularly problematic as a source of microplastic and chemical leaching, hazardous to marine plant and animal life (Root, 2020). All this shows the direct link between coastal and marine pollution and urban, recreational and touristic activities.

Table 2.2. Ocean Trash Index 2019: Major types of ocean trash collected from beaches worldwide through a beach clean-up initiative

Box 2.1. Top 10 plastic waste types collected from beaches worldwide

1. Food wrappers
2. Cigarette butts
3. Plastic beverage bottles
4. Plastic bottle caps
5. Straws and stirrers
6. Plastic cups and plates
7. Plastic grocery bags
8. Plastic takeout containers
9. Other plastic bags
10. Plastic lids

Country	weight of items (kg)	number of items	1	2	3	4	5	6	7	8	9	10
Selected sub-Saharan African countries												
Ghana	181,211	6,819,715	43.6k 0.63%	531.4k 7.8%	109.8k 1.6%	87k 1.3%	122.8k 1.8%	318.9k 4.7%	27.4k 0.4%	118k 1.73%	40.4k 0.6%	100.9k 1.5%
Kenya	100,008	256,793	18.4k 7.1%	3.8k 1.5%	34k 13.3%	26.9k 10.5%	8.2k 3.2%	6.2k 2.4%	9.5k 3.7%	7.8k 3.04	4.4k 1.7%	11k 4.3%
Nigeria	35,314	982,432	356.9 k 36.3%	1.8k 0.18%	117.2k 11.9%	66.2k 6.7%	22.2k 2.3%	8.9k 0.9%	4.1 0.4%	21k 2.1%	3.9k 0.4%	67.9k 6.9%
Senegal	200	725	45 6.2%	–	44 6%	18 2.5%	12k 1.7%	–	212 29.2%	3 0.4%	21 2.9%	–
South Africa	4,462	90,437	7.4k 8.2%	8.4k 9.3%	3k 3.4%	6.6k 7.3%	6.9k 7.6%	177 0.2%	2.5k 2.7%	955 1%	590 0.7%	1.3k 1.4%
Selected South Asian countries												
Bangladesh	1,583	30,176	3.2k 10.5%	9.9k 32.9%	2.6k 8.6%	970 3.21	513 1.7%	538 1.8%	1.1k 3.7%	1.6k 5.4%	652 2.2%	317 1.1%
India	29,808	49,142	7.2k 14.7%	2.2k 4.5%	7.7k 16.2%	2.3k 4.6%	891 1.8%	1.4k 2.9%	5k 10.2%	1.9k 3.9%	1.1k 2.3%	2.1k 4.3%
Maldives	2,823	7,351	362 4.9%	265 3.6%	2k 28.4%	173 2.3%	66 0.9%	100 1.4%	553 7.5%	844 11.5%	12 0.2%	88 1.2%
Sri Lanka	31,902	218,556	11.6k 5.3%	15.4k 7%	25.6k 11.7%	15k 6.9%	4.7k 2.1%	3.6k 1.6%	12k 5.5%	3.6k 1.7%	7.5k 3.5%	4.9k 2.2%

Source: Ocean Conservancy and International Coastal Cleanup (2020).

Note: The plastic categories that appear most frequently (in terms of share of collected items) have been highlighted in orange, and the categories appearing second most frequently have been highlighted in yellow.

2.4. Overview of the SUP waste problem in Bangladesh, Kenya and Nigeria

2.4.1. Bangladesh

About 87,000 tonnes of SUP waste is produced annually in Bangladesh (ESDO, 2019). SUPs used in urban areas account for 78 per cent of this waste, with rural areas responsible for the remaining 22 per cent. Of this waste, 86 per cent is dumped in landfills, which corresponds with the generally high percentage of mismanaged waste in Bangladesh. Per capita plastic consumption rose from 2.07 kilograms (kg) in 2005 to 3.5 kg in 2014 (Mourshed et al., 2017) with a cumulative production of 3,000 tonnes of plastic waste every day, which represents 8 per cent of all waste generated in Bangladesh. Another study showed the rising consumption of bottled water in Bangladesh and the generation of 28,846 tonnes of sachets (Shimul, 2013).

Following the discovery that thin plastic bags played a key role in clogging drainage systems resulting in disastrous flooding, Bangladesh became the first country in the world to introduce a ban on thin plastic bags – in 2002 (UNEP, 2018a). However, the ban is not strictly enforced and about 14 million polythene bags are still used every day in Dhaka city alone (Islam, 2019). Regulatory aspects related to SUPs in Bangladesh are discussed in chapter 7.

2.4.2. Kenya

In Kenya plastic constitutes an equally significant proportion of the solid waste management stream with an estimated share of 10–12 per cent, resulting in a total plastic waste stream of about 966,000 tonnes per year (Elliott et al., 2018). Data are not available on the share of SUPs in the overall plastic waste stream. However, a study by Oguge (2019) indicated that each year Kenya consumes 259,252 tonnes of plastic – characterized by imported raw plastics (184,708 tonnes), plastic packaging (44,086 tonnes) and recycled secondary plastics (30,475 tonnes) – of which only 46,988 tonnes are recycled. Approximately 38,565 tonnes/year are managed through landfills or incineration, and 173,698 tonnes/year find their way into the environment or to illegal dump sites. The result is an end-of-life scenario in which 18 per cent of plastic waste is recycled, 15 per cent goes to in landfills and 67 per cent ends up in open dumps.

In 2017 Kenya introduced the Environmental Management and Coordination Act, through Gazette Notice 2356, imposing a strict ban on importing, manufacturing or selling SUP bags and a hefty fine of $40,000 on companies that circumvent the ban and $500 for people who use SUP bags (Kenya Gazette, 2017). Despite the fact that plastic bags are still smuggled into Kenya, the ban has been considered successful as an estimated 80 per cent of the population has stopped using plastic carry bags since the ban was imposed (Barrett, 2020). Chapter 7 provides additional detail on issues and challenges related to domestic regulations for SUPs in Kenya.

With the beverage industry in Kenya having switched nearly completely to PET bottles from glass ones, the National Environment Management Authority tried to extend the plastic bag ban in 2018 to include SUP containers, such as bottles, made from PET. Instead, an industry-funded scheme run by the industry association PETCO was introduced to subsidize the collection and recycling of SUPs. However, with take-back points only sparsely available throughout the country, the scheme has had only rather limited success so far (Lerner, 2020). According to the Kenya Plastics Action Plan, Kenya recycled 5,778 Mt of PET for packaging in 2019 (KAM, 2019). In 2020, Kenya instated a complete ban on SUPs, including plastic bottles, on beaches and in national parks, forests and conservation areas (Mwangi, 2020).

2.4.3. Nigeria

Plastic waste is a major issue in Nigeria. According to a study by Henderson and Dumbili (2020), Nigeria generates about 42 Mt of solid waste per year, of which plastic waste represents 20 per cent. Plastic bottles, bags and sachets were identified as major contributors; however, specific data on SUP items are not available.

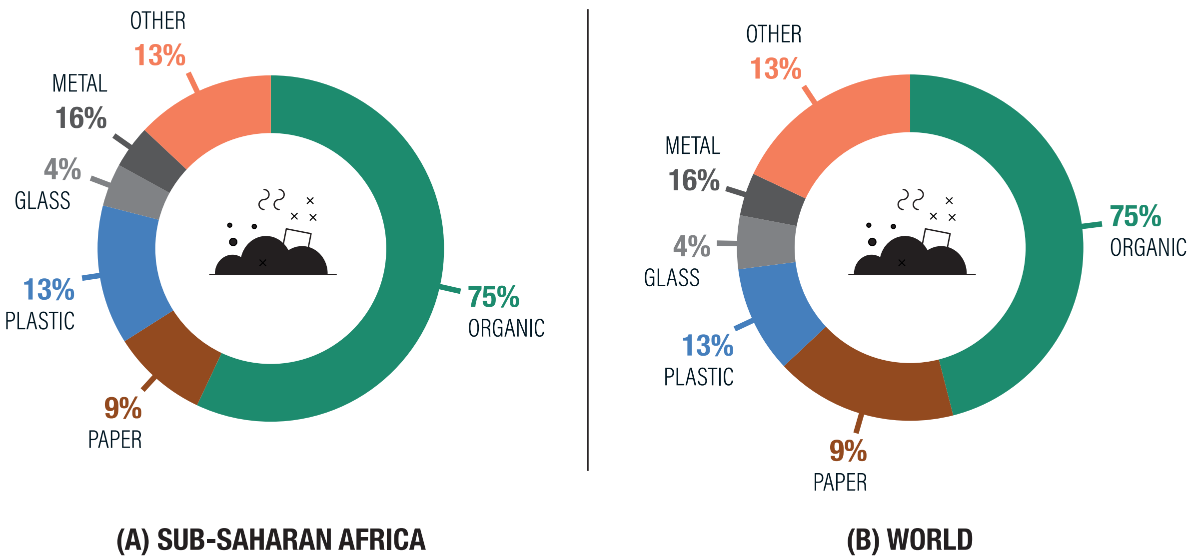
Due to the lack of proper waste management infrastructure and insignificant recycling rates, the Nigerian Government introduced a ban on plastic bags in 2019 through the Plastics Bag Prohibition Bill 2018 (Federal Republic of Nigeria, 2018). The proposed law still awaits final approval by the president (Akindele, 2020). The law stipulates that for any store that hands out plastic bags, the owner will either pay a fine of NGN 500,000 (about $1,300) or face a three-year jail sentence; manufacturers of plastic bags will pay NGN 5 million ($13,000) (Tomiwa, 2019). However, the law does not provide any exceptions for sachet water bags, which are used ubiquitously. Chapter 7 provides additional detail on issues and challenges related to domestic regulations for SUPs in Nigeria.

Some 70 per cent of Nigerians consumed at least one sachet of water on a daily basis in 2017. This amounts to about 60 million plastic sachets being used and disposed of each day (Henderson and Dumbili, 2020). This generated over 28,000 tonnes of plastic waste, of which 63 per cent was by households that lack formal waste disposal facilities. Some 13,600 tonnes of plastic waste from sachet packaging are generated annually (Wardrop et al., 2017). As regards waste management, there is a plastic sachet buy-back (buy-back pack) programme for consumers (Henderson and Dumbili, 2020).

2.5. Waste segregation and recycling rates for plastics, paper and metal

The average share of municipal solid waste collected in sub-Saharan Africa in 2012 was 44 per cent, although the coverage varied considerably between cities, ranging from less than 20 per cent to over 90 per cent, with the situation far worse in rural areas (UNEP, 2018b). With houses sparsely scattered over long distances, rural areas have little to no waste management services. Rural wastes that are not reused or recycled (such as through composting of agricultural waste) are illegally dumped or openly burned on-site. Although most rural waste is organic, the growing use of plastic, including in health-care material and disposable diapers, could exacerbate environmental problems caused by dumping. Even for urban waste, uncontrolled or controlled dumping is the most common practise, although the number of cities shifting from uncontrolled disposal to sanitary landfills is increasing. The share of plastics in municipal solid waste in sub-Saharan Africa is larger than the global average, at 13 per cent, with paper making up 9 per cent and glass and metal each making up 4 per cent (Figure 2.1). Similar shares are noted for Lagos and Nairobi, the two major cities in Nigeria and Kenya (Table 2.3).

Figure 2.1. Municipal solid waste composition: Sub-Saharan Africa and world



Source: UNEP (2018b).

Table 2.3. Municipal solid waste composition: Lagos and Nairobi

Country	Composition (percentage)					
	Organic	Paper/ Cardboard	Plastic	Glass	Metal	Others
Lagos (Nigeria)	62.6	10.7	4.2	2.5	2.2	19.7
Nairobi (Kenya)	65.0	6.0	12.0	2.0	1.0	15.0

Source: UNEP (2018b).

There are few empirical data on recycling in Africa as it is often carried out informally at the household level or by the informal sector. In the latter case, waste pickers and itinerant buyers recover most post-consumer recyclables (including plastic, paper, glass and ferrous metals) and supply them to recycling businesses. Nonetheless, the average recycling rate for municipal solid waste recycling rate in Africa is estimated at about 4 per cent. There are few formal recycling systems. Although some municipalities have established on-site recovery facilities, as in South Africa, UNEP observed that “most are not well-equipped with the required logistics for waste” (UNEP, 2018b). In this regard, it may be worth exploring business opportunities related to the creation of well-regulated regional hubs for processing recyclables at scale (Pacini et al., 2020). Such an effort could increase export opportunities for countries in the region, not only for recyclable plastic but also for non-hazardous waste and scrap – for example, plastic substitutes such as glass and metals such as aluminium. For example, Senegal and Tunisia in 2007 earned $20 million and $30 million from exports of recovered metal scrap, aluminium and plastics (UNEP, 2018b). Recent bans by countries such as China could affect countries that have not established local end-use markets. South Africa has established some resilience to such shocks in global recycling markets; for example only 4.6 per cent of paper and packaging collected for recycling is exported (UNEP, 2018b).

South Africa has also established itself as a recycling hub and was the first country in sub-Saharan Africa to have a PET bottle-to-bottle recycling plant. It is capable of producing PET flakes for export to countries such as China, India and Malaysia (where it is used to create polyester for use in clothing, linen and other fabric products) as well as for processing into new bottles to serve the domestic market (Davies et al., 2020). Similar recycling hubs could emerge in Kenya and Nigeria to serve East African and West African markets.

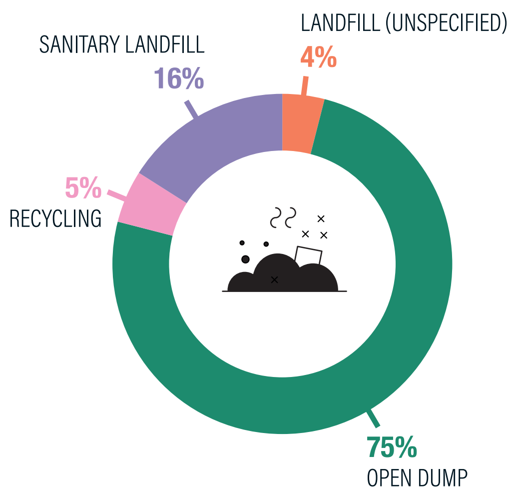
In Nigeria, recycling is an entirely voluntary waste management practice and is nether regulated nor coordinated. Yet, the country’s informal waste recycling sector has created a worthwhile market segment and also generated employment opportunities. As described by Ezeudu et al. (2019, p. 14), “The operational system comprises … scavengers (as sellers), dealers (whose role is to mop-up buying from scavengers), and small and medium scale industries that finally use the recyclables”. Recycler associations and cooperatives also exist mainly in metal scrap, plastic waste and electronic waste. Practices essential for waste management such as sorting are not compulsory and therefore also not enforceable (Ezeudu et al., 2019).

In Kenya, the reuse and recycling levels reportedly range from about 1 per cent for organics, to 5 per cent of plastic waste, 8 per cent for paper waste, 100 per cent of reusable metal scrap and an unknown share of glass (Global Recycling, n.d.). In 2020, an estimated 1,400 tonnes of recyclables were burned or illegally treated, about 200 tonnes officially dumped and 150 tonnes recovered. UNEP and the International Union for the Conservation of Nature (2020) estimated that only 27 per cent of the plastic waste generated in Kenya is collected: 8 per cent for recycling and 19 per cent for disposal in unsanitary landfills or dumpsites. A small share (13.6 per cent) of the plastic waste collected for recycling is also exported (UNEP and IUCN, 2020). The Sustainable Waste Management Bill 2021, introduced in the Kenyan Parliament, provides for waste segregation at the source (Ministry of Environment and Forestry, Kenya, 2019a).

As in Nigeria most recycling activity is carried out by the informal sector involving private companies, individuals and non-governmental organizations including through public-private partnerships (Global Recycling, n.d.). For example, Kenyan company Eco-post manufactures commercially viable, highly durable and environmentally friendly fencing posts from collected plastic waste. The fencing posts are widely used throughout Kenya; the company created over 300 jobs and had saved 1 million kilogrammes of plastic waste as of 2018 (UNEP, 2018b). A number of international initiatives involving collaboration with foreign countries (e.g. Denmark, Germany, Japan) and companies (e.g. HP, Dell) are also under way, with the objective of improving solid waste management infrastructure and practices including, for instance, for medical waste and e-waste. Plastic waste is also a potential sector of interest, with an estimated recycled volume of just 38,000 tonnes out of a total volume of 270,000 tonnes of plastic packaging waste (Global Recycling, n.d.). A recent enumeration estimates that there are 51 plastic recyclers in Kenya, most of them based in Nairobi. However, challenges remain with regard to raising needed investment capital and creating a transparent and predictable guiding policy framework for private sector participation. Waste sorting as well as a market for organic waste and certain inorganic waste fractions such as extruded polystyrene foam (XPS) and low-grade plastics are still lacking and will need to be created to enable effective waste management and recycling at scale. (Global Recycling, n.d.).

In South Asia, plastics make up about 8 per cent of waste composition; paper and cardboard comprise 10 per cent, glass 4 per cent and metal 3 per cent. As illustrated in Figure 2.2, open dumping is the most common method of waste disposal and treatment in South Asia with a 75 per cent share of all methods. Only 16 per cent goes to a sanitary landfill and 5 per cent is recycled (Kaza et al., 2018).

Figure 2.2. Waste disposal and treatment: South Asia



Source: Kaza et al. (2018).

More data are available on recycling activity in South Asia than in sub-Saharan Africa, although the data are also based on survey estimates and, in many cases, available only at the city or municipal level. A country report prepared by various governments as an input for the 10th Regional 3R and Circular Economy Forum in Asia and the Pacific webinar outlines some of the progress made in achieving the voluntary and non-binding Ha Noi 3R Declaration – Sustainable 3R Goals for Asia and the Pacific 2013–23 (UNCRD and Ministry of Environment, Government of Japan, 2020) adopted in 2013. Table 2.4 shows some of the responses to a 2020 survey of governments in the Asia-Pacific region by the United Nations Centre for Regional Development (UNCRD) on household waste segregation, recycling and recovery rates for plastics, paper and metals, as well as the existence of recycling infrastructure and facilities in selected countries in South Asia, on the basis of available data.

Although recycling rates for wastes that can be recycled in countries such as Bangladesh may be high, most of it is carried out by the informal sector. For example, in Dhaka 120,000 urban poor are involved in recycling, with 15 per cent of the total inorganic waste generated in the city being recycled daily (Matter et al., 2013). Source storage and separation of organic, inorganic and hazardous wastes are highly neglected by city dwellers but carried out subsequently by a network of informal workers who collect recyclable wastes and supply them to processing factories for reuse as raw materials. Ahsan et al. (2014, p. 8) observe that "In Bangladesh, a few local small industries fully depend on the availability of reclaimed material for reprocessing. Commonly non-hazardous wastes are recycled in Bangladesh and there is a strong need for recycling of hazardous or special wastes". Although plastic is the most widely recovered material throughout Bangladesh, only a small share (2.5 per cent) – 20,000 tonnes out of a total of 800,000 tonnes – is recycled (UNDP, 2019).

Strategies to reduce the amount of mixed waste and increase waste segregation can further increase recycling rates and the volume of recycled material being produced, thereby leading to enhanced domestic sales and export opportunities for such recyclables (Matter, 2013). Better financing and infrastructure as well as more organized systems involving sorting and extended producer responsibility (EPR) (Box 2.1) can also increase the volumes available for recycling and enable better economies of scale in sub-Saharan Africa and South Asia. At the same time, given the importance of the informal sector in recycling activity, mechanisms must also be found to ensure that restructuring and reform initiatives such as EPR do not lead to job losses or displacement. Informal workers should be absorbed into and assigned valuable roles within these more organized structures. As noted in a waste sector survey carried out in South Africa, the "waste flows between the informal and formal sectors result in these two subsectors being bound to, and dependent upon, each other" (Godfrey et al., 2016, p.2).

Table 2.4. Waste segregation and recycling survey responses, selected countries in South Asia

Country	Household participation in source segregation of municipal waste streams	Recyclable plastic 1. Recycling rate 2. Resource recovery rate from waste streams 3. Resource recovery facilities or infrastructure in cities	Paper 1. Recycling rate 2. Resource recovery rate from waste streams 3. Resource recovery facilities or infrastructure in cities	Metal 1. Recycling rate 2. Resource recovery rate from waste streams 3. Resource recovery facilities or infrastructure in cities
Bangladesh	Low or not satisfactory (<50%)	1. High (>70%), based on volume of recyclable waste utilized or volume of waste collected for recycling 2. Average (50–~60%) 3. Only a few major cities	1. Average (50–~60%), based on volume of recyclable waste utilized or volume of waste collected for recycling 2. Average (50–~60%) 3. Only a few major cities	1. Very high (>90%), based on volume of recyclable waste or utilized or volume of waste collected for recycling 2. Very high (>90%) 3. Only a few major cities
Bhutan	Low or not satisfactory (<50%)	1. High (>70%), based on recyclable waste collected or estimated generation of waste 2. Average (50–~60%) 3. Only a few major cities	1. High (>70%), based on recyclable waste collected or estimated generation of waste 2. Average (50–~60%) 3. Only a few major cities	1. Very high (>90%), based on recyclable waste collected or estimated generation of waste 2. High (>70%) 3. Only a few major cities
India	High (<70%)	1. High (>70%) 2. Average (50–~60%) 3. Only a few major cities	1. High (>70%) 2. Average (50–~60%) 3. Only a few major cities	1. Average (50–~60%) 2. Poor (<50%) 3. Only a few major cities
Maldives	Average (50–~70%) (in islands where projects are implemented)	1. Average (50–~60%), based on recyclable waste collected or estimated generation 2. Average (50–~60%) 3. Only a few major cities	1. Poor (<50%), based on recyclable waste collected or estimated generation 2. Poor (<50%) 3. Only a few major cities	1. Average (50–~60%), based on recyclable waste collected or estimated generation 2. Average (50–~60%) 3. Only a few major cities
Nepal	Low or not satisfactory (<50%)	1. Average (50–~60%), based on recyclable waste collected or estimated generation 2. Poor (<50%) 3. Only a few major cities	1. Average (50–~60%), based on recyclable waste collected or estimated generation 2. Poor (<50%) 3. Only a few major cities	1. High (>70%), based on recyclable waste collected or estimated generation 2. Poor (<50%) 3. Only a few major cities
Pakistan	Does not exist	1. Average (50–~60%) 2. Average (50–~60%) 3. Only a few major cities	1. Very high (>90%) 2. High (>70%) 3. Only a few major cities	1. Very high (>90%) 2. High (>70%) 3. Only a few major cities
Sri Lanka	Average (50–~70%)	1. Average (50–~60%), based on volume of recyclable waste utilized or volume of waste collected for recycling 2. Average (50–~60%) 3. Only a few major cities	1. Average (50–~60%), based on volume of recyclable waste utilized or volume of waste collected for recycling2. Average (50–~60%) 3. Only a few major cities	1. Average (50–~60%), based on volume of recyclable waste utilized or volume of waste collected for recycling 2. Average (50–~60%) 3. Only a few major cities

Sources: Adapted from UNCRD survey on progress towards the Hanoi 3R Goals in Bangladesh (UNCRD, 2020a), Bhutan (UNCRD, 2020b), India (UNCRD, 2019a), Maldives (UNCRD, 2016), Nepal (UNCRD, 2019b), Pakistan (UNCRD, 2019c), Sri Lanka (UNCRD, 2019d).

Box 2.1. Extended producer responsibility

The Organisation for Economic Co-operation and Development (OECD) defines extended producer responsibility (EPR) as "a policy approach under which producers are given a significant responsibility – financial and/or physical – for the treatment or disposal of post-consumer products. Assigning such responsibility could in principle provide incentives to prevent wastes at the source, promote product design for the environment and support the achievement of public recycling and materials management goals. Within the OECD the trend is towards the extension of EPR to new products, product groups and waste streams such as electrical appliances and electronics. One of the aims when introducing EPR schemes has often been to give producers an incentive to change product design in environmentally benign ways, for example by making it easier to reuse or recycle the products" (OECD, 2005b). The OECD has developed a framework for assessing the costs and benefits of EPR, as the economic question is often raised as to whether the environmental gains from the operation are sufficient to justify the costs. This can be resolved only through careful and objective quantitative research on the effects of actual EPR programmes. The OECD notes that it is important to have "more extensive and systematic ex post evaluation of environmental policy instruments, to facilitate policy learning between countries, and to stimulate reflective processes of policy re-evaluation and improvement within countries" (2005a, p. 7).

Although the data in Table 2.4 are largely based on survey responses by governments, they indicate that in many South Asian countries recycling facilities do exist. Further strengthening and scaling up these facilities could be explored as a way of strengthening the ecosystem for end-of-life disposal of not only plastics but also substitutes. In addition, a switch from SUPs to reusable materials such as paper and metal that can eventually be recycled could open up further economic opportunities, including for waste pickers, and employment created through the establishment of recycling facilities. The opportunities for trade in recyclables are also interesting, particularly in countries where the volumes generated may not allow for the economic operation of recycling plants at scale. For example, in Bhutan, since setting up recycling plants was costly and the amount of recyclables collected insufficient to set up a recycling plant in the country, all recyclables have been transported to India. However, pilot schemes for bins to facilitate household waste segregation and PET bottle crushing plants are under way (UNCRD, 2020 Bhutan).

More granular recycling data for specific towns in Bangladesh also produce interesting observations such as a stable and expanding market in the country for cardboard and waste, a high recovery rate for metals, high resale value for all types of metals and relatively lower value for scrap metal and tin as compared with aluminium waste. The data also highlight other challenges that may need to be addressed. These include the cost of transporting raw waste materials to recycling centres, the lack of access to banking facilities that leave upstream actors vulnerable and unable to expand their scale of operations and issues related to health, safety and child labour (UNDP, 2019).

CHAPTER 3. KEY END-USE CATEGORIES FOR PROBLEMATIC SUPS: IDENTIFYING POTENTIAL SUBSTITUTES IN BANGLADESH, KENYA AND NIGERIA

This chapter analyses the situation of SUPs in the three case-study countries: Bangladesh, Kenya and Nigeria. The large-scale use of SUPs in these countries (as in many) has preceded the setting up of waste-handling systems and infrastructure, resulting in the accumulation of litter. The objective of this chapter is to identify possible substitute materials that could be used in each of these three countries to replace fully or partially four categories of SUP products. It provides insights on when and why plastic became the standard material for these products worldwide as well as which type of plastic is commonly used.

3.1. Four major SUP product categories

Throughout this chapter, the focus is on four product categories for which SUP items are the new norm and that also constitute a major share of the resulting SUP waste stream (Ocean Conservancy, 2020). These four product categories are grocery and other bags; takeout/takeaway containers for food and beverages; plates, straws and cutlery; and bottles and sachets for water and other beverages.

The main reasons for their ubiquity are shared across all product categories studied. Regardless of the plastic type used, the production costs for SUP items are mostly claimed to be low in comparison with the most commonly offered alternatives. In addition, the range of plastic materials available enables producers to apply different plastics for different uses while emphasizing different material strengths, such as flexibility for bags or sturdiness for takeaway food containers. What all plastics also have in common are their low weight and their ability to be easily made into various shapes and forms. Yet although these SUP items have several advantages, they also cause significant environmental impacts: they have attracted worldwide attention mainly because plastics take decades or centuries to disintegrate in the environment. Major impacts derive from the end-of-use phase when they are improperly discarded, as is the case in the three case-study countries. Low recycling and waste management rates in all three countries are attributable to a lack of proper waste management infrastructure. In addition, consumer behaviour and lack of awareness contributes to these impacts and results in significant environmental damage. As a way to address the challenges, all three countries have introduced bans on plastic bags, albeit with mixed success. Limiting factors are a lack of strict penalties, enforcement capacity or economically viable alternatives.

3.1.1. Grocery and other bags

Plastic bags have been around for decades. In 1965, the HDPE-based plastic bag was patented by a Swedish company called Celloplast. HDPE had been invented in 1953 and subsequently gained popularity as a material for many uses, mainly because of its characteristics as a material that is relatively light and mouldable yet strong. Over the next decade, plastic bags gained an 80 per cent share of the grocery bag market within Europe as they were marketed by the plastics industry as a superior, cheaper and stronger alternative to the paper bags then used in grocery stores. In the mid-1980s, the plastic bag also became internationally successful when the global patent was overturned and larger grocery stores and chains in the United States and other countries around the world replaced their paper bags with plastic ones. HDPE-based bags are relatively thick and durable, yet less flexible than the thinner and lighter-weight LDPE-based bags (Venkatesan and Sukeforth, 2017).

In comparison with alternative materials plastic bags are often the cheaper option, offering similar or better properties, and thus retain a significant global market share. According to Plastics Oceans (2021), approximately 500 billion plastic bags are used annually worldwide, with an average service time of 15 minutes. As such, plastic bags make up the biggest group of SUP items sold worldwide. The global market for plastic bags and sacks was estimated at $20.4 billion in 2020 (Global Industry Analysts, 2021). Not surprisingly, the non-profit Ocean Conservancy (2020), which organizes beach clean-up activities, lists plastic grocery bags and other plastic bags seventh and ninth on their top 10 list of items found most often during their marine and coastal collection efforts in 116 countries in 2020.

3.1.2. Takeout/takeaway containers for food and beverages

Takeaway food is not a modern invention. Quite to the contrary, food-to-go has been sold for centuries. In ancient Rome, citizens could buy takeout food from what was known as a thermopolium, which literally translates as “a place where something hot is sold” (Andonovska, 2017). With the growing use of plastic in all aspects of life, plastic food containers have become popular among restaurants over the last decades. Today, various types of plastic options are used for takeaway food, including boxes, containers, clamshells, trays, crates and sealable food savers. Clamshells are made from various plastics such as polystyrene, PVC, polyester and polypropylene. The advantage of using these plastics lies in their ability to be made into different forms, shapes and sizes, through either thermoforming or injection moulding. Containers made from extruded polystyrene foam (XPS), also known as polystyrene, are also often used to make trays, cups, to-go containers and various other types of packaging supplies (UNEP, 2020c).

Plastic is used mainly for its ability to provide flexible solutions for various applications. It can be used for both cold and hot food and is a hygienic and durable option. Its sturdiness enables forms with compartments, which allows separation of parts of a meal and thus offers a significant advantage over other solutions such as aluminium foil pans, which lose their shape easily. SUP takeaway containers are also highly competitive from a price perspective and thus offer the most practical and affordable solution for street and restaurant food as well as grocery store purchases.

Although in recent years consumers have increasingly become aware of the downsides of using SUPs, the COVID-19 pandemic has further fuelled the demand for takeout/takeaway containers, with restaurants closed to diners in many parts of the world. Plastic takeout containers are eighth on the list of items most often found during beach clean-ups by Ocean Conservancy (2020).

3.1.3. Plates, straws and cutlery

Plastic straws, along with plastic cutlery and plates, have also been subjected to heavy criticism over recent years, mainly because of the rise of plastic waste that is ending up on seashores around the world. According to Ocean Conservancy (2020), plastic straws and stirrers were the fifth and plates and cups the sixth most commonly found items during their beach clean-up activities. In line with these findings, the European Commission decided to ban the use of these items in the European Union as part of Directive 2019/904, starting from 3 July 2021 (European Commission, 2019).

A typical drinking straw is made of the thermoplastic polymer polypropylene, which was invented in the 1950s. Polypropylene is also often also used for plastic plates and cutlery, along with polystyrene. Both materials can be manufactured at relatively low cost and are quite durable, light and resistant to heat, water, salt and acids. They can also be moulded into various shapes and sizes and thus offer the perfect properties for such products (Malpass and Band, 2012).

Plastic plates and cutlery became popular for outdoor activities such as birthday parties and barbeques after the end of the Second World War. Nowadays, plastic cutlery is not only regularly offered as part of takeout food, but also often used by public cafeterias in schools or hospitals together with plastic plates. This is mainly for cost reasons, as SUP-based options are usually cheaper than reusable materials that also need to be replaced and washed, such as silverware and ceramic plates (Gray, 2018).

3.1.4. Bottles and sachets for water and other beverages

Plastic bottles used for water and other drinks are the third most collected item on Ocean Conservancy’s list, closely followed by plastic bottle caps in fourth place (Ocean Conservancy, 2020). Although plastic bottles can be made of HDPE, LDPE and polypropylene, most are made of PET. The first PET bottle was patented by DuPont scientist Nathaniel Wyeth in 1973 (Blakeborough, 2001). Since then, plastic bottles and especially PET bottles have seen an enormous uptake around the world. According to data from Euromonitor International’s global packaging trends report, 1 million plastic beverage bottles were purchased every minute in 2017, and it was estimated that by 2021, 583.3 billion PET bottles would be sold annually (Laville and Taylor, 2017). From a functional perspective, much like other SUP items, plastic bottles are cheap to produce, lightweight and sturdy and can also safely contain fizzy drinks. In addition to bottles, in some West African countries, such as Ghana and Nigeria, plastic sachet bags (containing 500 ml) have become the standard drinking-water package for the water industry. Sachet water bags, believed to have been invented in 1990 by Victoria Bolanle Oginni, consist of heat-sealed polyethylene-based plastic sleeves (Henderson and Dumbili, 2020).

3.2. Identification of plastics substitute feedstocks

As a response to the fast-growing challenge of mismanaged plastic waste, three distinct kinds of reactions to the problem are currently visible at a global level: national bans on certain forms of plastic, as highlighted for example for bags; reduction in plastic litter through better waste management and promotion of naturally degrading feedstocks to replace plastics; and promotion of repeated use of products. The following subsections provide an overview of alternative feedstocks relevant for the three countries under study along with a description of the methodology followed to identify the feedstocks.

3.2.1. Methodology for identification of alternative materials

The methodology applied to identify alternative feedstocks consisted of four main steps.

i. Preparation of a long list of possible materials: On the basis of published accounts and market availability of the four products in different parts of the world, a long list of potential candidate feedstocks was developed. The purpose of drawing out this long list was to create an initial hypothesis that could be taken to local partners in the respective countries for validation or amendment. This list consisted of about 30 promising materials, mainly originating from terrestrial and marine biomass.

ii. Local materials scrutiny: The long list of materials was then scrutinized in consultation with country-based partners and supplemented with locally produced materials that had not surfaced in the first step. New feedstocks were added during this step if there was abundant production locally and they could be used for manufacturing for at least one of the four products. The purpose of this step was to ensure that all feedstocks relevant for the countries under study were included for the next level of scrutiny.

iii. Local market scrutiny: The next step was to filter the feedstocks on the basis of actual availability of finished products made from them. At this stage, the list retained only those feedstocks that were being used for any of the four products for sale in the local market or being produced by local entrepreneurs within the country. The purpose of this step was to eliminate feedstocks that were only theoretical possibilities as there was no evidence of actual use in the countries under study.

iv. Polylactic acid-based scrutiny: This final step eliminated all feedstocks that were being transformed into PLA for the production of end products made with bioplastics. The purpose of this step was to keep only those feedstocks that could be used for products that do not require specialized industrial composting facilities. Such facilities are not available in Bangladesh, Kenya and Nigeria and thus only products compostable under natural conditions can be expected to reduce litter.

Although the priority remained the identification of biobased alternatives, bottles, glass and aluminium were kept as part of the substitute assessment, as they represent the only alternative materials available for certain uses. With regard to end-of-life treatment, glass is not associated with the same challenges that plastics face, and aluminium containers have a material value and thus see a relatively high recycling rate even in countries where the waste management sector relies highly on informal activities.

3.2.2. Suitable alternative materials available in the three case-study countries

a. Bangladesh

The country's ecology includes a long sea coastline, numerous rivers and tributaries, lakes, wetlands, evergreen forests, semi-evergreen forests, hill forests, moist deciduous forests, freshwater swamp forests and flat land with tall grass. Rich in biomass, it has a long history of biobased industries and crafts, notably using jute, murta (Schumannianthus dichotomus) and other reeds, bamboo, cane and wood (Convention on Biological Diversity, 2021a). Table 3.1 shows materials now emerging as sources of sustainable and environmentally friendlier merchandise with potential to substantially substitute for plastics in making the four SUP products used in Bangladesh. Although seaweed possesses some theoretical potential as a substitute material, it was not considered for this study, as no kelp- or algae-based products have been brought to market, despite some initial government efforts to promote research and entrepreneurial interest.

Table 3.1. Bangladesh: Alternative materials

Product	Alternative feedstock
Grocery and other bags	Jute
	Cotton
	Paper
	Murta and other reeds
	Banana pseudo-stem/leaf
Plastic takeout/takeaway containers for food and beverages	Paper
	Banana pseudo-stem/leaf
Plastic plates, cutlery, straws	Clay
	Paper
	Wood
	Areca leaf
	Bamboo
	Stainless steel
	Coconut shell
Plastic bottles for water and other beverages	Glass
	Aluminium

b. Kenya

The ecological zones and habitats of Kenya include lowland and mountain forests, wooded and open grasslands, semi-arid scrubland, dry woodlands, inland aquatic, and coastal and marine ecosystems (Convention on Biological Diversity, 2021b). Table 3.2 shows materials now emerging as sources of sustainable and environmentally friendly merchandise with potential to substantially substitute for plastics in making the SUP products used in Nigeria.

Table 3.2. Kenya: Alternative materials

Product	Alternative feedstock
Grocery and other bags	Paper
	Jute, sisal
	Cotton-hemp
	Wool
Plastic takeout/takeaway containers for food and beverages	Paper/cardboard

Table 3.2. Kenya: Alternative materials (cont.)

Product	Alternative feedstock
Plastic plates, cutlery, straws	Wood
	Paper/cardboard
	Wheat
	Bamboo
	Stainless steel
Plastic bottles for water and other beverages	Glass
	Aluminium

c. Nigeria

The natural ecosystems of Nigeria range from semi-arid savannah to mountain forests, seasonal floodplain environments, rainforests, freshwater swamp forests and diverse coastal vegetation. Although Nigeria derives about 80 per cent of its external earnings from the oil industry, about 70 per cent of the population derives its livelihood from agriculture (Convention on Biological Diversity, 2021c).

Table 3.3 shows materials now emerging as sources of sustainable and environmentally friendly merchandise with potential to substantially substitute for plastics in making the four SUP products used in Nigeria. It shows that several feedstocks are available for use in manufacturing replacements of specific SUP items to carry and serve meals. Some of these feedstocks are used across the world. Others are found abundantly in specific regions and have long been used in local cottage industries. Still others are essentially agricultural waste remaining after harvesting the main edible product. If the use of these feedstocks could be scaled up substantially, it would serve the twin purposes of enabling and supporting the other two actions, implementation of a plastic ban and reduction of litter by natural decomposition.

Table 3.3. Nigeria: Alternative materials

Product	Alternative feedstock
Grocery and other bags	Paper
	Jute
	Cotton-hemp
	Wool
Plastic takeout/takeaway containers for food and beverages	Paper/cardboard

Table 3.3. Nigeria: Alternative materials (cont.)

Product	Alternative feedstock
Plastic plates, cutlery, straws	Wood
	Paper/cardboard
	Wheat
	Bamboo
Plastic bottles for water and other beverages	Glass
	Aluminium

Table 3.4 provides an illustrative list of potential plastic substitutes and their properties, as identified by UNCTAD. These include many of the materials identified in the three case-study countries as well as others, such as ceramic, which have not been considered for further analysis.

Table 3.4. Potential plastic substitutes, illustrative list

Product	Origin	Main uses	Properties	Health impact	Environmental impact
Glass	Sand-based	Food and pharmaceutical products containers Construction material	Solid Fragile Flexible Insulating Microwavable Heavy Tradable	Very good insulating material Non-toxic	Does not contain chemicals or carbon (only minerals) Reusable Recyclable Very slow degradation by erosion
Aluminium	Mineral	Tableware Container and ornamental uses	Solid Flexible Supports heat Lightweight Tradable	Non-toxic	Reusable Recyclable Very slow degradation by erosion
Natural fibres	Plant-based (e.g. jute, cotton, coconut, palm)	Textiles Packaging Ropes Clothes Furniture Other	Strong Flexible Light Fully tradable	Non-toxic Production can allow carbon storage	Reusable Biodegradable Recyclable, but with impact on land use
Paper Cardboard	Cellulose-based	Bags Boxes Packaging Decoration Inputs to industrial products	Flexible Light Fully tradable	Non-toxic	Reusable Biodegradable Recyclable, but increase in use may generate pressure on timber extraction, unless from managed or certified forests or from recycling
Organic wastes	Bagasse Rice husks Corn husks Other organic wastes	Cups Cutlery Dishes Construction components and inputs for composite materials	Flexible Light Tradable	Non-toxic Some insulation properties	Biodegradable

Source: Adapted from Barrowclough and Vivas Eugui (2021).

CHAPTER 4. PRELIMINARY REVIEW OF LIFE-CYCLE IMPACT ASSESSMENT OF POTENTIAL SUBSTITUTES FOR SUPS AND IMPLICATIONS

4.1. Introduction to life-cycle assessment

This chapter explores the sustainability dimensions of scaling up the use of specific feedstocks identified as having potential in the three case countries both to manufacture the four SUP products under study and to replace those that do not degrade under natural, uncontrolled conditions. Life-cycle assessment (LCA) was applied to assess and compare feedstock options on environmental sustainability performance. The methodology assesses potential environmental impacts of a product or service over its life cycle. During the modelling of a product system, LCA covers all life-cycle stages of a product, starting with mining and extraction of required raw materials and going through manufacturing, distribution, use and end-of-life treatment (UNEP, 2021). LCA studies provide an overview of environmental impacts associated with various life-cycle stages and thus help to avoid burden shifting from one stage to another or between environmental impact categories. They help to avoid unintended consequences and provide a better information basis for decision makers (UNEP, 2021). A full-fledged LCA study can be time-consuming, but a screening LCA provides a high-level overview and helps identify the main hot spots.

LCA is internationally standardized as an assessment tool through ISO standards 14040 (ISO, 2006b) and 14044 (ISO, 2006c), which divide the process of carrying out an LCA into four phases:

i. Goal and scope definition: During the first phase of the assessment the objective (goal) of the assessment is determined as are the methodological approach and choices (scope), including the functional unit, system boundaries and allocation procedures.

ii. Life-cycle inventory (LCI) analysis: ISO defines LCI analysis as the "phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle." Inputs in this context include the required energy, raw or manufactured materials and energy and materials coming from transportation. Outputs are defined as all emissions into the atmosphere, water and land as well as solid wastes and other releases to the environment. These unit processes represent the product system that needs to be analysed as defined by the system boundaries set in the goal and scope phase.

iii. Life-cycle impact assessment (LCIA): During LCIA all the resources and emissions identified in the LCI analysis are connected to the corresponding impacts they cause. Various LCIA methods exist to quantify the potential environmental impacts of a product system. Recently the term "footprint" has been adopted as the metric(s) used to report LCA results addressing an area of concern, which can be an aspect of the natural environment, human health or resources (ISO, 2017).

iv. Interpretation: The last phase of the process is evaluation of the results in the context of the defined goal and scope to provide the assessment and make recommendations.

To have a reference point for quantifying the environmental footprint, a functional unit is used to conduct an LCA. A functional unit is defined as the quantified performance of a product system for use as a reference unit (ISO 14040:2006). As such, the functional unit provides a reference to which the inputs and outputs can be related. The functional unit also enables the comparison of two products that fulfil the same function (Curran, 2016). The definition of the functional unit is an important part of the assessment. The specific considerations for the product categories considered in this chapter are outlined in the following section.

Although the process of conducting an LCA is standardized, methodological choices made by those carrying out the study can have a significant impact on outcomes. Studies from different sources are thus difficult to compare unless they used the same functional unit and same scope definition. In addition, LCA studies rely strongly on the availability of LCI data to model potential environmental impacts across global supply chains. If such data are not available for a particular country, substitute data from countries in similar regions with comparable development levels are used for the modelling. As such, LCA studies generally do not offer a precise modelling of exact impacts but rather enable a comprehensive understanding of a product system and thus the context within which the product is applied.

4.2. Assessing the sustainability performance of various feedstock options

On the basis of an analysis of the alternative materials identified for Bangladesh, Kenya and Nigeria, this section summarizes the findings from LCA studies relevant for the four product categories. The summaries are based on several LCA meta-studies conducted recently for the United Nations Environment Programme (UNEP, 2020a, 2020b, 2020c), supplemented with LCAs on specific products such as straws. Following the summaries, the footprint results of the screening LCAs for the four product categories are presented.

Although not included as alternatives in the previous sections, one PLA-based product (corn fibre for grocery bags in Bangladesh) and petrochemical-based products (polypropylene for grocery bags in Kenya and Nigeria, and for water sachets in Nigeria) were considered in the LCA screening. This was done to allow comparison with LCA studies that show plastic is superior to organic feedstocks on most environmental parameters. In this context, it is crucial to note that impacts such as clogged drainage systems or plastics in bodies of water are not captured by LCA methodology, so the apparently better sustainability performance of plastic in LCA studies must be viewed in that context (Sonnemann and Valdivia, 2017).

4.2.1. Conclusions from LCA studies

The following subsections summarize conclusions from LCA studies at three levels: conclusions in general, conclusions on plastics and non-plastics as a whole, and conclusions on specific product categories.

a. Conclusions in general

The location of production, consumption and end-of-life disposal activities has an important influence on a product's environmental impacts. Differences in the energy mix and the proportion of energy drawn from clean or renewable energy sources also affect environmental performance. The potential impact on climate change is significantly greater from fossil fuel-based energy sources than from renewable energy sources. (See annex I, at the SMEP Trade and Pollution Dashboard under Reports at http://bit.ly/SMEP_UNCTAD).

Waste management practices, systems and infrastructure vary across countries, and often across regions within the same country. The environmental performance of a product thus depends also on how waste is managed and how much of it goes to landfills, incineration or recycling for final disposal.

Finally, the consumption and post-consumption behaviour of the local population also affects the environmental performance of the products consumed. Such behaviour includes, for example, frugal or wasteful consumption habits, salvaging of resources, and responsible disposal of waste.

b. Conclusions about plastics and non-plastics as a whole

A few general conclusions on overall environmental performance can be derived from the LCA meta-studies reviewed. With respect to climate change, acidification, eutrophication, water use and land use, the environmental performance of both SUPs and reusable plastics for the product categories under study was found in nearly all cases to be better than the non-plastic options reviewed in the LCA meta-studies.

However, even though the impact of littering and microplastics is not well accounted for in these studies, they suggest that when it comes to impacts associated with littering on land and especially in water bodies, and on microplastic contamination, SUPs fare much worse than the other available options. To this end, it is thus important to note that any ranking that draws on various impact category assessments depends on what environmental aspects are relevant for a specific case or what aspect is given the highest priority.

The studies further highlight that reuse is a key differentiating factor for environmental performance for all reviewed materials. This holds especially true for reusable plastics, which present lower environmental impacts than single-use alternatives, provided they get reused. If discarded prematurely, the performance of reusable plastics will be worse because their greater material and energy inputs in the production phase in comparison to SUPs need to be offset by increasing the number of times they are reused.

Products made of naturally biodegradable feedstocks generally provide better environmental performance when properly composted. Otherwise, the meta-studies noted, improperly managed degradation processes could result in higher impacts on climate, eutrophication and acidification; for example, due to the low methane capture efficiency in landfills. In contrast, products made from non-biodegradable materials show better performance when material recovery at the end of life is ensured.

c. Conclusions about specific product categories

i. Grocery and other bags

For SUP grocery bags, the advantage for climate change impact does not outweigh the littering impact: although the contribution of plastic bags to impacts on climate change is negligible, they are responsible for a significant share of the littering impact when compared with other products (UNEP, 2020a).

ii. Takeaway containers

Among single-use alternatives, containers made from polystyrene or EPS and paper perform better environmentally than those made from PET, PLA and polypropylene. Among reusable alternatives, containers made from reusable polypropylene perform better than those made from reusable glass.

The role of containers in avoiding food spoilage, spilling or wastage is an important factor in determining their environmental performance. As the environmental impact of the food in a container is much greater than that of the container itself, any container that reduces food leakage or spoilage will have much better performance overall than an alternative that could render food unfit for use (UNEP, 2020c).

iii. Straws

Straws are a peculiar product in the sense that a significant amount of material is lost during their cutting and shaping. The impact of biodegradable straws on climate change is therefore much greater than that of polypropylene straws due to the loss of material. However, energy consumption during the production of biobased options is significantly lower, and their overall carbon footprint can be lowered with more efficient use – less wastage – of material (Boonniteewanich et al., 2014).

An LCA study from South Africa also shows that paper straws have lower potential impacts on climate change than polypropylene alternatives because of the fossil fuel-based energy mix. According to the study, glass and steel straws need to be reused 23 and 37 times respectively to have a lower environmental impact than single-use options (Chitaka et al., 2020). A study from the United States shows that reusable steel straws present the lowest carbon footprint when washed without warm water (Boonniteewanich et al., 2014). A Brazilian study shows that plastic straws are the option with the best environmental performance; however, plastic straws have a greater impact on littering than other alternatives (Zanghelini et al., 2020).

iv. Bottles for water and other beverages

For bottles, the options available for materials – namely plastic, glass and metal – are very different. For single use, glass bottles perform worse environmentally than plastic or metal, for all impact categories. As beverage bottles, especially water bottles, are usually not significantly contaminated or affected during use, their recycling rates are higher than those of other products. For plastic-based bottles, environmental impact is directly linked to the proportion of virgin or recycled material used in their production (UNEP, 2020b).

4.2.2. Screening LCAs

This section provides an overview of results from a number of screening LCAs conducted in 2021 for the study products and countries by the authors of this chapter. For all products, the LCI considered the technology and the material and energy use of production processes. Energy mix and waste management scenarios prevailing in the three countries were considered. (For energy profiles of the three case-study countries, see annex I.) The screening LCAs were conducted by the authors of this chapter in 2021. Different input data were used; they were obtained from the international LCI database EcoInvent (2021) and from the Mexican life-cycle database (Centro de Análisis de Ciclo de Vida y Diseño Sustentable, 2021). The impact analysis used the environmental impact assessment method of Goedkoop et al. (2008). As expected, complete inventory data required for screening LCAs were not available for all identified feedstocks, products and countries. Nevertheless, on the basis of expert judgment by the authors and consultation with local partners and using data from countries with similar agricultural and waste management practices, screening LCAs were completed for the products and countries shown in Table 4.1.

In some cases, product categories had to be rearranged with slightly different nomenclature than that used in previous sections. For example, there were no studies or inventory data for cutlery, which therefore had to be left out. Plates and takeout containers have similar characteristics and were therefore grouped together. For straws, sufficient data were available and thus they were considered as a separate category.

Table 4.1. Product-country-feedstock combinations for which screening LCAs were done

Product	Country	Feedstocks
Grocery and other bags	Bangladesh	Paper, corn fibre, jute, and cotton
	Kenya	Non-woven polypropylene, woven polypropylene, paper, jute, cotton, wool
	Nigeria	Woven polypropylene, paper, jute, cotton, wool
Takeout/takeaway containers and plates for food	Nigeria	Paper or cardboard, plantain leaves, wheat, bamboo
Straws	Nigeria	Paper, wheat, stainless steel
Bottles	Nigeria	Sachets, recycled PET, glass

a. Product category screening LCA – all three case-study countries

i. Goal and scope

The functional unit for the screening LCAs was the number of bags required to carry one month's shopping by the average shopper in the country of analysis.

Data used for these screening LCAs are shown in Table 4.2.

Table 4.2. Waste scenarios used for plastic bags for screening LCAs

Country	Average number of bags used per person per week	Share of bags recycled (%)	Waste management scenario (% disposed by method)
Bangladesh	10 SUP bags[a]	0	Open dump: 45 Landfill: 53 Recycled: 2
Kenya	34.2 SUP bags (pre-ban) 3.6 non-woven polypropylene bags (post-ban)[b]	18	Open dump: 67 Landfill: 15
Nigeria	34.2 SUP bags (pre-ban) 3.6 non-woven polypropylene bags (post-ban)	12[c]	Open dump or landfill: 80 Open burning: 8

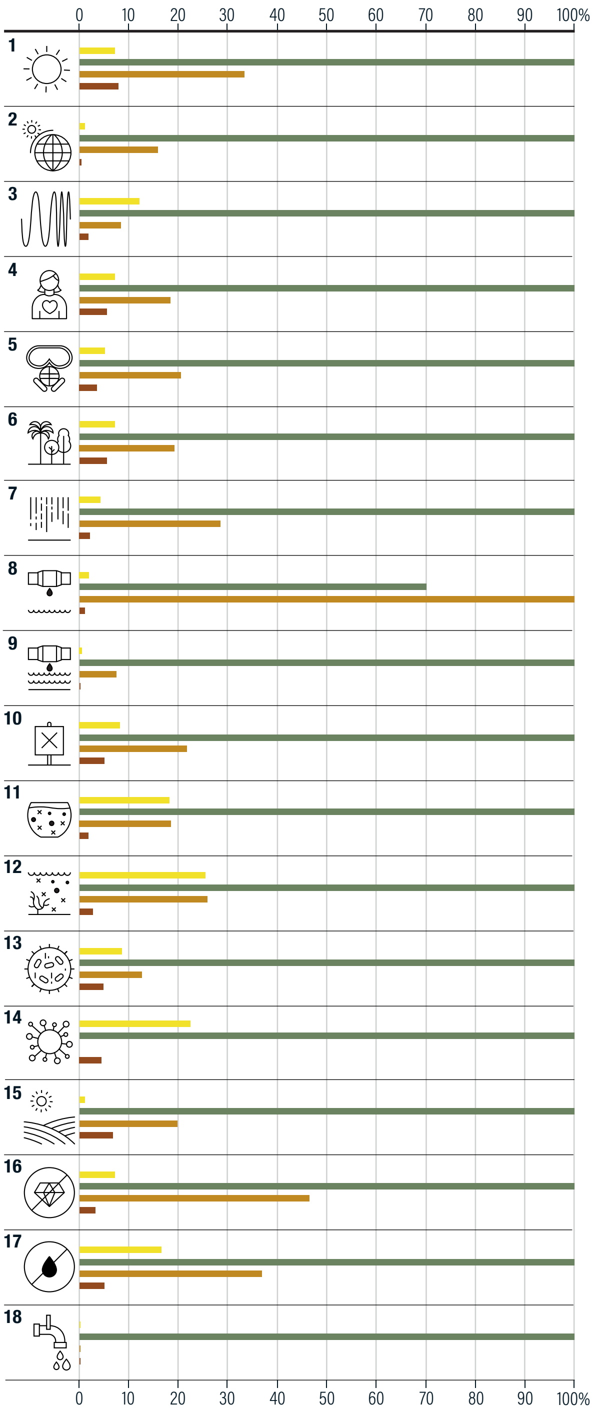
Sources: As noted.

a Uddin et al. (2018).

b Same as Kenya (Enge, 2018), assuming similar consumer patterns.

c Babayemi et al. (2018).

Figure 4.1. Bangladesh: Environmental impacts by life-cycle stage of alternative bag types



Source: Based on data from EcoInvent (2021) as well as the Mexican life-cycle database (Centro de Análisis de Ciclo de Vida y Diseño Sustentable, 2021).

ii. LCIA and interpretation

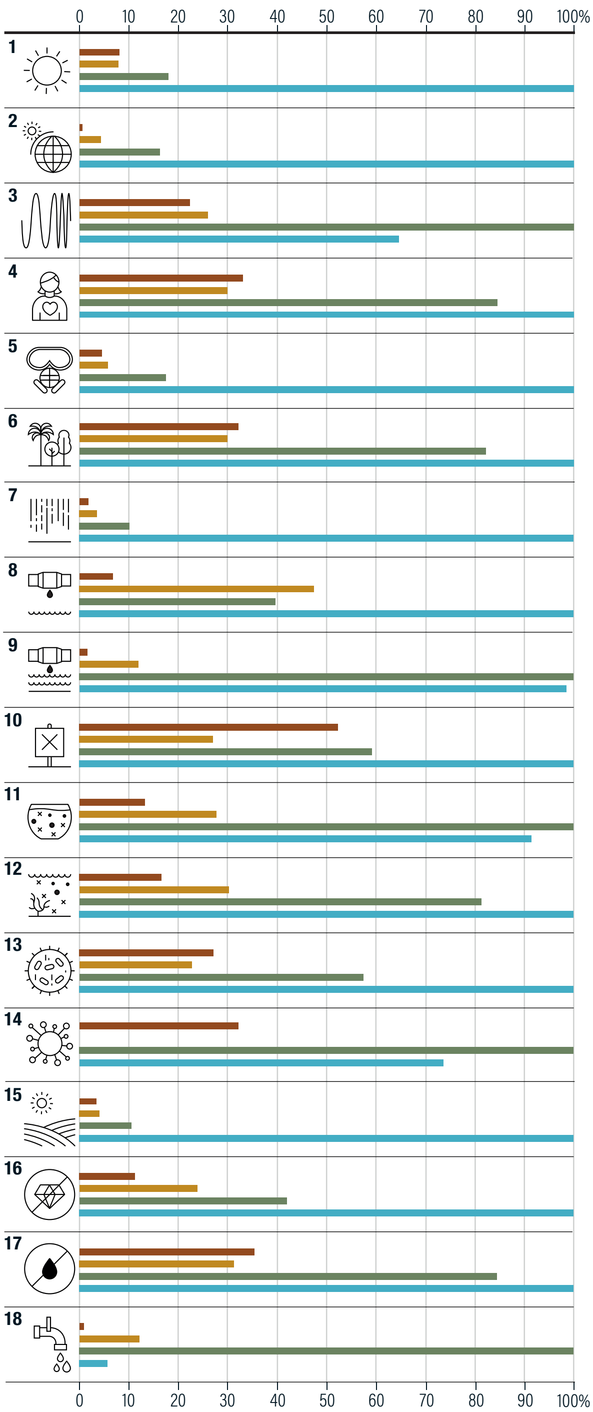
This section provides graphics comparing environmental performance for several products, created from the quantitative results of the screening LCAs (section 4.2.2). In them, 100 per cent represents the product with the largest environmental footprint for that indicator. For each indicator, the impacts of alternative products appear as fractions of that amount; i.e., the higher the bar, the greater the impact of the alternative relative to the option with the greatest impact. Comparisons should be viewed by individual indicators.

As highlighted in Figure 4.1, paper bags have the smallest environmental footprint; the next best options are corn fibre and jute bags. For jute, many LCA studies have underscored the benefits of production and consumption (Jahan, 2009; Islam, 2012; Roy and Hassan, 2016; Dilshad, 2018). Jute is pivotal to the economy in Bangladesh, along with the textile industry. In the latter, efforts are under way to lower environmental impacts due to water and electricity consumption in textile production, such as through the Partnership for Cleaner Textiles (2021). The same has not yet happened for jute yarn production. This may change with the recently begun privatization of State-owned jute mills (Bangladesh Jute Mills Corporation, 2021a). The remaining feedstocks identified – namely murta, a local perennial wetland reed, and fibre from banana pseudo-stem and leaf, which is waste material left after fruit harvesting – could have even smaller environmental footprints but could not be included in the screening LCA due to lack of inventory data.

Box 4.1. List of potential environmental impacts

1. GLOBAL WARMING
2. STRATOSPHERIC OZONE DEPLETION
3. IONIZING RADIATION
4. OZONE FORMATION HUMAN HEALTH
5. FINE PARTICULATE MATTER
6. OZONE FORMATION TERRESTRIAL ECOSYSTEMS
7. TERRESTRIAL ACIDIFICATION
8. FRESHWATER EUTROPHICATION
9. MARINE EUTROPHICATION
10. TERRESTRIAL ECOTOXICITY
11. FRESHWATER ECOTOXICITY
12. MARINE ECOTOXICITY
13. CARCINOGENIC TOXICITY
14. NON-CARCINOGENIC TOXICITY
15. LAND USE
16. MINERAL RESOURCE SCARCITY
17. FOSSIL RESOURCE SCARCITY
18. WATER CONSUMPTION

Figure 4.2. Kenya: Environmental impacts by life-cycle stage of alternative bag types



ALTERNATIVE BAG TYPES

PAPER JUTE COTTON WOOL

Source: Based on data from EcoInvent (2021) as well as the Mexican life-cycle database (Centro de Análisis de Ciclo de Vida y Diseño Sustentable, 2021).

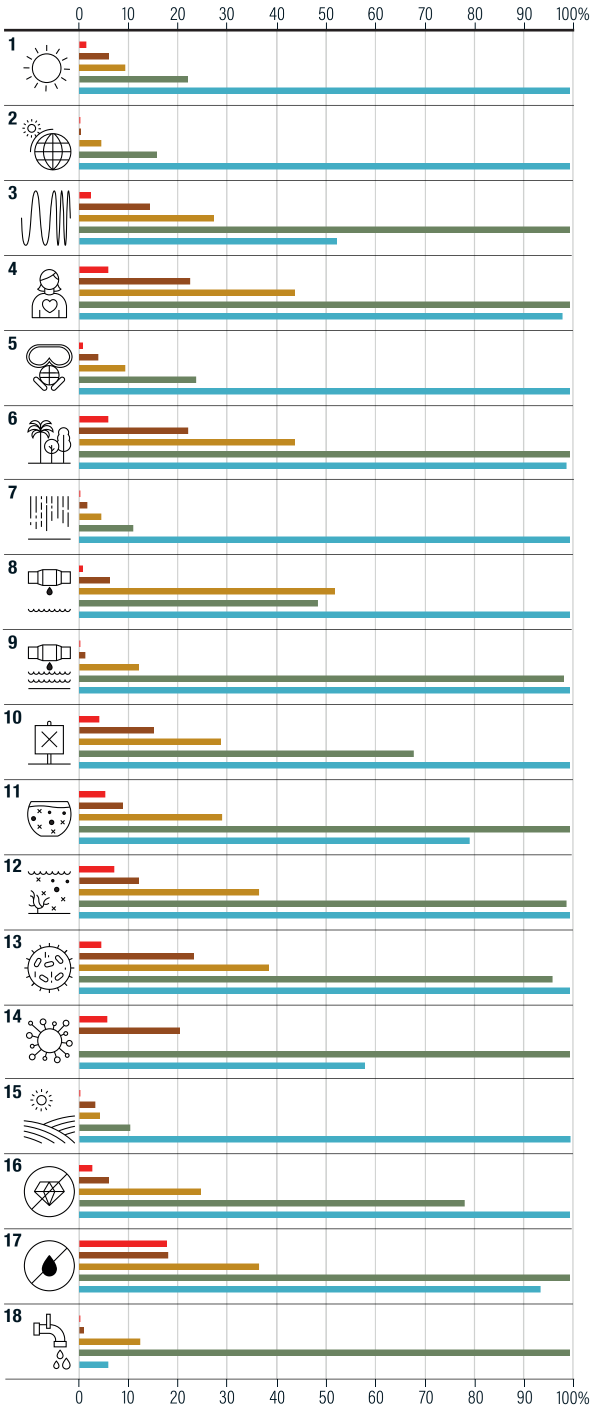
Although they are petroleum based, non-woven and woven polypropylene feedstocks were included in the analysis for Kenya as displayed in Figure 4.2, because a market study has indicated that consumers prefer non-woven polypropylene because of its cost and visual appeal. Different colours and sizes were available at most supermarkets and outdoor markets in Nairobi (Enge, 2018). As shown in Figure 4.2, the sustainability performance of the polypropylene bags was better than that of the selected substitute materials. In addition, the country has a polypropylene recycling industry. Yet specific recycling rates for polypropylene bags could not be obtained, and thus it remains unclear to what degree they could help reduce plastic pollution caused by littering. Paper bags and jute bags present the smallest environmental footprint of the plastic substitute feedstocks analysed. Another feedstock identified was sisal. Sisal bags are already used at the same rates as cotton and wool bags (Enge, 2018); however, sisal could not be included in the screening LCA owing to the lack of inventory data.

For Nigeria, as for Kenya, woven polypropylene bags had the smallest environmental footprint, as depicted in Figure 4.3. The next best options are paper and jute bags. Paper bags are not suitable for the wet season and therefore have limited acceptance among most residents (Iheukwumere et al., 2020). Jute bags produced from the jute plant popularly called "ewedu" are being used in the country and have been recommended as an eco-friendly option (Iheukwumere et al., 2020; Nwafor and Walker, 2020).

Box 4.1. List of potential environmental impacts

1 GLOBAL WARMING
2 STRATOSPHERIC OZONE DEPLETION
3 IONIZING RADIATION
4 OZONE FORMATION HUMAN HEALTH
5 FINE PARTICULATE MATTER
6 OZONE FORMATION TERRESTRIAL ECOSYSTEMS
7 TERRESTRIAL ACIDIFICATION
8 FRESHWATER EUTROPHICATION
9 MARINE EUTROPHICATION
10 TERRESTRIAL ECOTOXICITY
11 FRESHWATER ECOTOXICITY
12 MARINE ECOTOXICITY
13 CARCINOGENIC TOXICITY
14 NON-CARCINOGENIC TOXICITY
15 LAND USE
16 MINERAL RESOURCE SCARCITY
17 FOSSIL RESOURCE SCARCITY
18 WATER CONSUMPTION

Figure 4.3. Nigeria: Environmental impacts by life-cycle stage of alternative bag types



ALTERNATIVE BAG TYPES

WOVEN POLYPROPYLENE | PAPER | JUTE | COTTON | WOOL

Source: Based on data from EcoInvent (2021) as well as the Mexican life-cycle database (Centro de Análisis de Ciclo de Vida y Diseño Sustentable, 2021).

b. Country screening LCAs – all product categories in Nigeria

In this section, the remaining three product categories under study are evaluated for Nigeria, where the most reliable data were available. For Bangladesh and Kenya, no further products were analysed owing to the lack of data and the limited time available to conduct the study.

i. Goal and scope

The functional unit for the following screening LCA has been defined as a container or plate that can hold 200 grams of food while maintaining its characteristics for later consumption in the country. The data used for this screening LCA are for containers of the same capacity as those available in Lagos, Nigeria, made of bamboo, paper or plantain leaf. The bamboo container was 25 x 20 cm and weighed 29 grams; the paper container was 16 x 19 cm and weighed 9 grams, and the plantain-leaf container had a 20 cm diameter and weighed 9.3 grams (requiring six plantain leaves and cotton yarn). The waste scenarios were based on data adapted from Babayemi (2018), as outlined earlier.

ii. LCIA and interpretation

As shown in Figure 4.4, the paper-based (cardboard) container is the option with the smallest environmental footprint. However, the contribution of paper-based alternatives to climate change is the greatest due to emissions from paper degradation at the disposal site. Plant-based alternatives (plantain leaf and – mostly imported – wheat) have a small environmental footprint overall, but their impact on water use is the highest. The bamboo-based container has the

Box 4.1. List of potential environmental impacts

1. GLOBAL WARMING
2. STRATOSPHERIC OZONE DEPLETION
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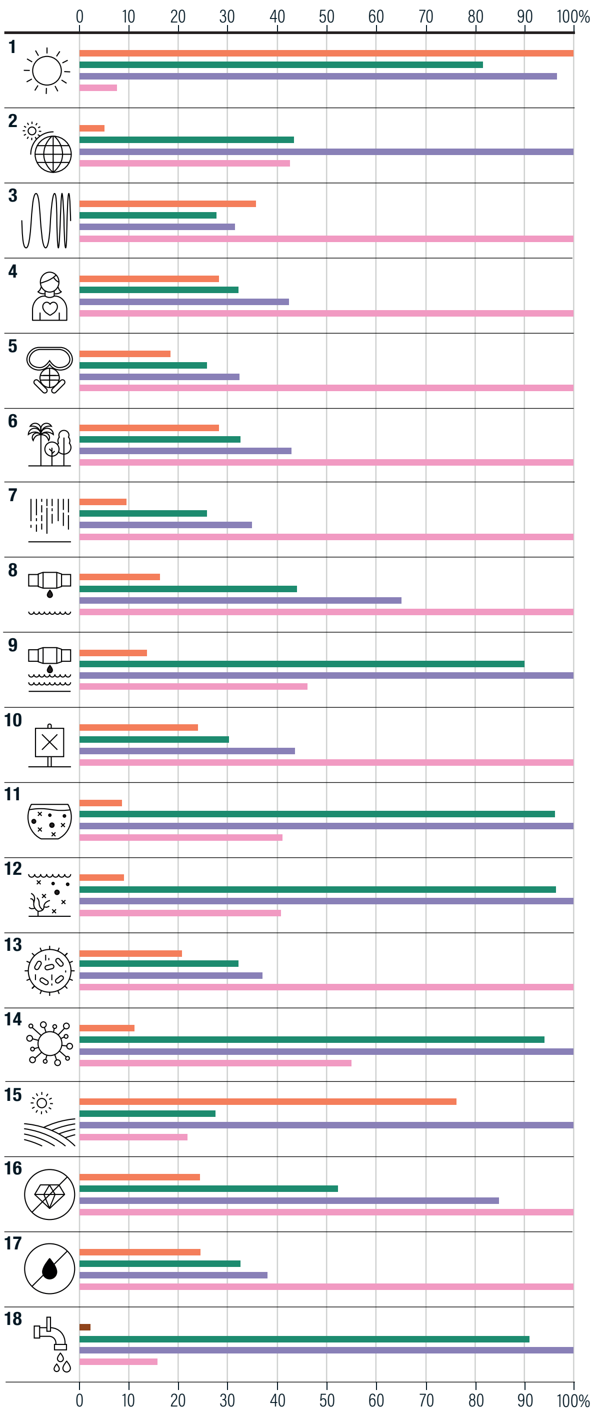
5. FINE PARTICULATE MATTER
6. OZONE FORMATION TERRESTRIAL ECOSYSTEMS
7. TERRESTRIAL ACIDIFICATION
8. FRESHWATER EUTROPHICATION
9. MARINE EUTROPHICATION
10. TERRESTRIAL ECOTOXICITY
11. FRESHWATER ECOTOXICITY
12. MARINE ECOTOXICITY
13. CARCINOGENIC TOXICITY
14. NON-CARCINOGENIC TOXICITY
15. LAND USE
16. MINERAL RESOURCE SCARCITY
17. FOSSIL RESOURCE SCARCITY
18. WATER CONSUMPTION

Figure 4.4. Nigeria: Environmental impacts by life-cycle stage of alternative food container types



smallest environmental impact on climate change due to carbon sequestration in the plant, but has the greatest contribution to potential impacts on soil. As such, whichever option is taken, burden shifting from one impact category to another may occur.

Figure 4.5 shows that paper production is the main contributor to the environmental footprint, and that paper decomposing in landfills and open dump sites contributes greatly to global warming and marine eutrophication through leachate of nitrogen. Therefore, if aspects such as sustainable forest management and composting or recycling of paper can be better managed, better environmental performance can be achieved across all or most impact categories.

c. Product screening LCA – straws in Nigeria

i. Goal and scope

The functional unit for this LCA screening is the number of straws consumed per capita in the country.

In addition to paper and reusable metallic options, wheat straws are also a viable option in Nigeria (Gbadamosi, 2021). The LCI considered 12 disposable straws and 1 reusable straw (data adapted from Chitaka et al., 2020 and Babayemi, 2018). The weight of paper and steel straws was obtained from Chitaka et al. (2020) and the weight of wheat straws from Zanghelini et al. (2020). Nigeria imports straws mainly from China, Spain and Belgium. For the analysis it was assumed that the straws are produced in China. The waste scenarios were based on landfills and open dumps, as adapted from Babayemi (2018).

ALTERNATIVE FOOD CONTAINER TYPES

CARDBOARD | PLANTAIN LEAF | WHEAT | BAMBOO

Source: Based on data from EcoInvent (2021) as well as the Mexican life-cycle database (Centro de Análisis de Ciclo de Vida y Diseño Sustentable, 2021).

Box 4.1. List of potential environmental impacts

1 GLOBAL WARMING
2 STRATOSPHERIC OZONE DEPLETION
3 IONIZING RADIATION
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12 MARINE ECOTOXICITY
13 CARCINOGENIC TOXICITY
14 NON-CARCINOGENIC TOXICITY
15 LAND USE
16 MINERAL RESOURCE SCARCITY
17 FOSSIL RESOURCE SCARCITY
18 WATER CONSUMPTION

Figure 4.5. Nigeria: Environmental impacts by life-cycle of paper takeaway containers

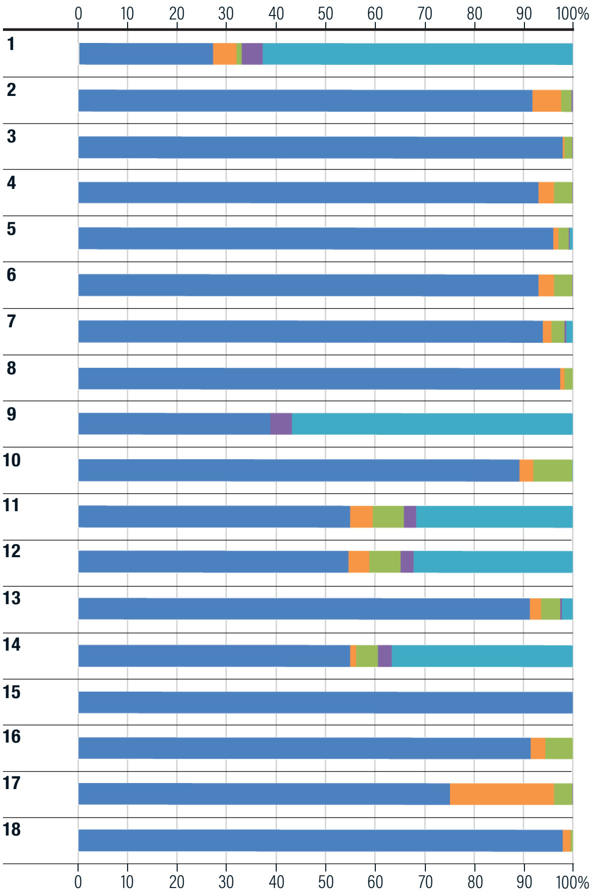

Figure 4.6. Nigeria: Environmental impacts by life-cycle stage of alternative straw types

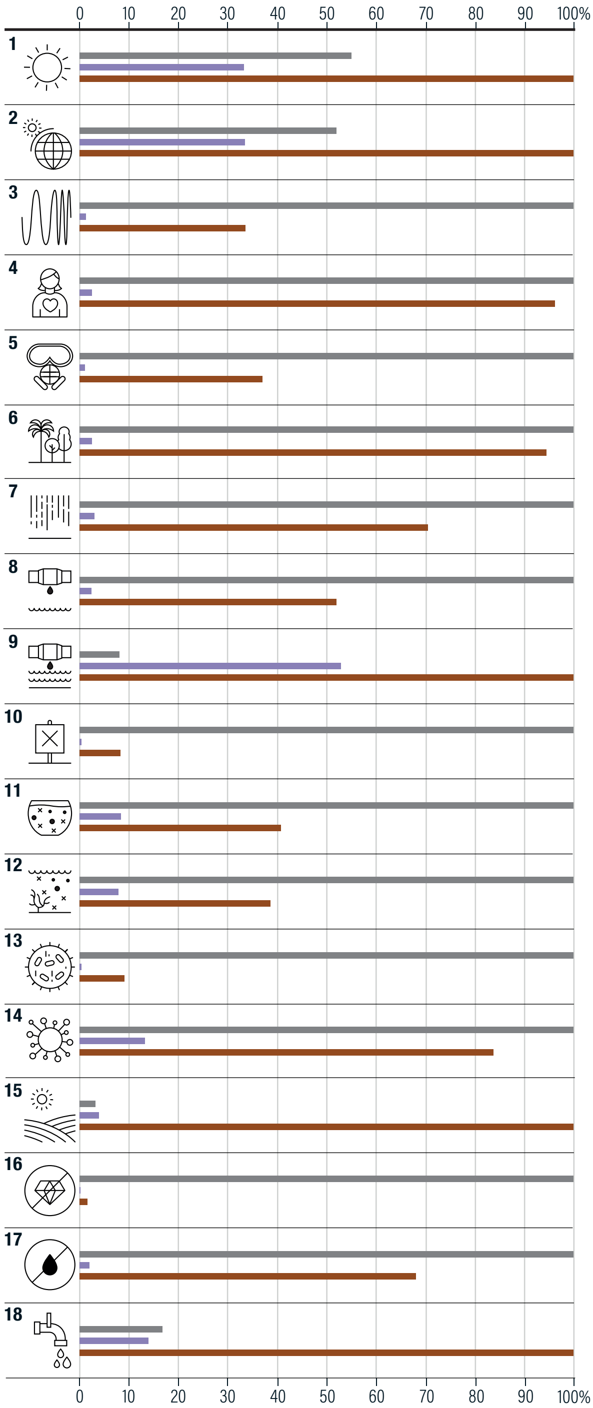

FIGURE 4.5. LIFE-CYCLE OF PAPER TAKEAWAY CONTAINERS

PAPER | ELECTRICITY | DISTRIBUTION | SANITARY LANDFILL | OPEN DUMP

FIGURE 4.6. ALTERNATIVE STRAW TYPES

STAINLESS STEEL | WHEAT | PAPER BOARD

Source: Based on data from EcoInvent (2021) as well as the Mexican life-cycle database (Centro de Análisis de Ciclo de Vida y Diseño Sustentable, 2021).

Box 4.1. List of potential environmental impacts

1 GLOBAL WARMING
2 STRATOSPHERIC OZONE DEPLETION
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17 FOSSIL RESOURCE SCARCITY
18 WATER CONSUMPTION

ii. LCIA and interpretation

As shown in Figure 4.6, the paper straw option has better environmental performance than the steel straw. Its drawbacks include increased use of land and water and greater potential impacts on ozone depletion and global warming than the wheat straw alternative. In this case, wheat straw is the option with the smallest environmental footprint.

The feedstock is obtained from the stem of the crop, which is currently considered waste. Using it as a by-product will increase the value of the crop (Zanghelini et al., 2020). As shown in Figure 4.7, the main impacts are associated with the production, distribution and end-of-life phase, hence if the wheat is produced locally and the straw is composted, the environmental footprint would be significantly reduced.

d. Product screening LCA – bottles for water in Nigeria

i. Goal and scope

The functional unit used for the following screening LCA on bottles for water in Nigeria is 1,000 litres of water in Nigeria to be consumed on the go.

The screening LCA includes products widely used in the country, namely water sachets, recycled PET bottles and returnable glass bottles. Aluminium was not considered owing to the lack of data.

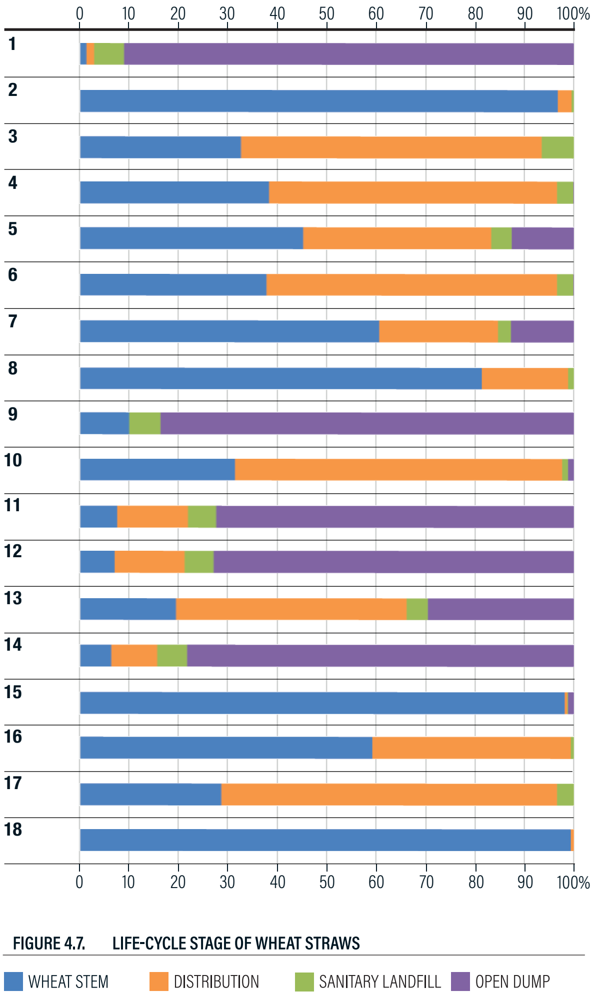
In order to carry out the screening LCA, the following LCI data were considered:

i. A 300 ml returnable glass bottle weighs 303 grams (g), and an aluminium crown (bottle cap) weighs is 2.05 g. Returnable glass bottle schemes are a successful model used by beverage companies in Nigeria (Osifuwa, 2020). The recycling rates used in the LCI are the ones reported by Osifuwa (2020).

ii. A 500 ml sachet of polyethylene weighs 1.67–1.85 g. A study for Saki town indicated that empty sachets of water were mostly disposed of in the waste bin (63 per cent); the rest are dropped on the ground (28 per cent), thrown in the gutter (4 per cent) or burned (5 per cent) (Wardrop, 2017). Imports of bag material come mostly from China.

iii. A 500 ml recycled PET bottle weighs 32 g. This option was considered because it is an alternative to SUPs recommended by the governments of Kenya and Nigeria and because both countries have recycling programmes.

Figure 4.7. Nigeria: Environmental impacts by life-cycle stage of wheat straws



Source: Based on data from EcoInvent (2021) as well as the Mexican life-cycle database (Centro de Análisis de Ciclo de Vida y Diseño Sustentable, 2021).

ii. LCIA and interpretation

As shown in Figure 4.8, petroleum-based feedstocks had the smallest environmental footprint. Even if the glass container were returned and reused, its environmental performance remains low. As shown in Figure 4.9, the analysis of life-cycle stages reveals that the heat used for washing used bottles is a large contributor to the environmental footprint. This contribution could be reduced if alternative options could be found.

Figure 4.8. Nigeria: Environmental impacts by life-cycle stage of alternative water container types

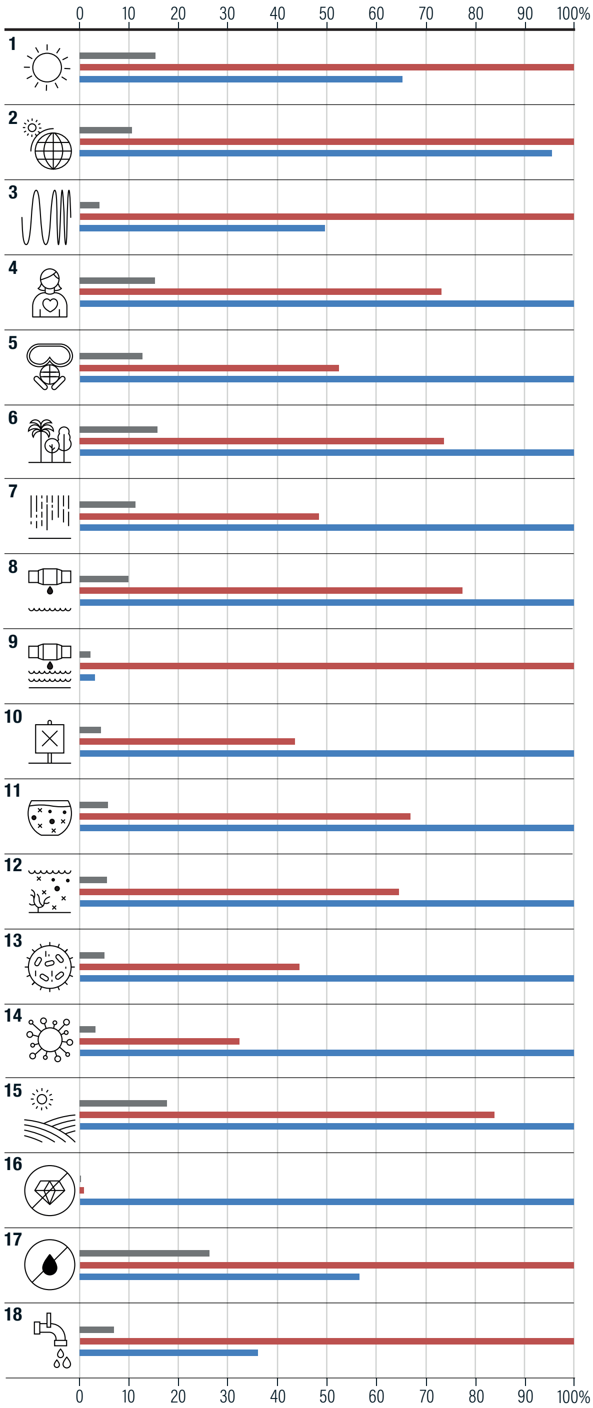
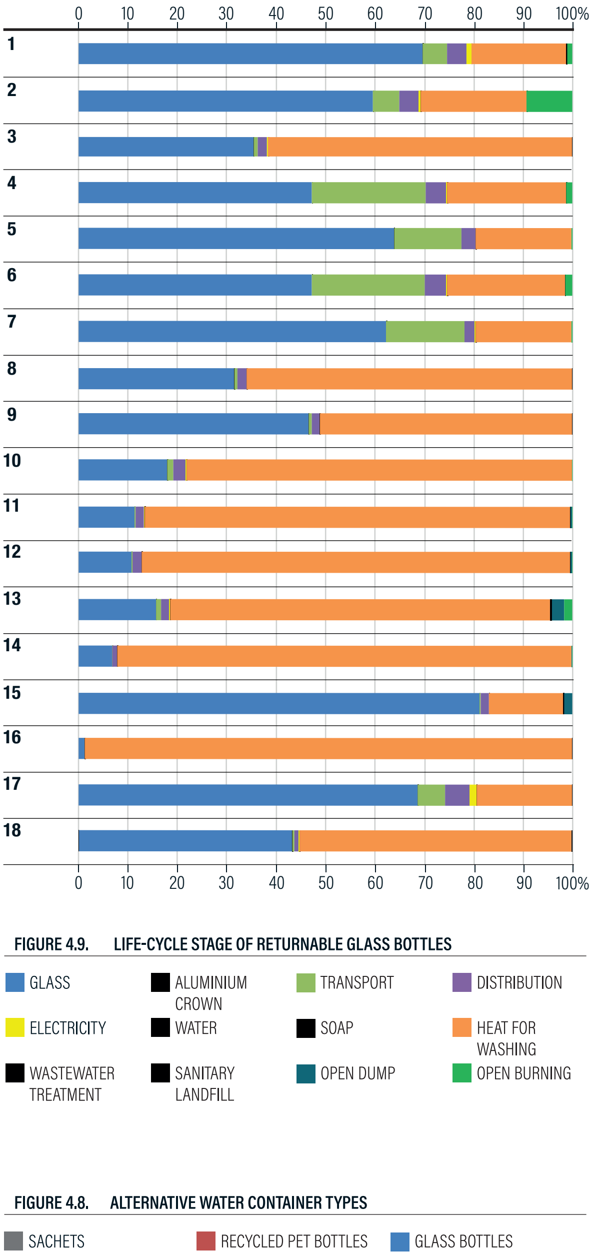


Figure 4.9. Nigeria: Environmental impacts by life-cycle stage of returnable glass bottles



Source: Based on data from EcoInvent (2021) as well as the Mexican life-cycle database (Centro de Análisis de Ciclo de Vida y Diseño Sustentable, 2021).

Box 1.1

1 GLOBAL WARMING
2 STRATOSPHERIC OZONE DEPLETION
3 IONIZING RADIATION
4 OZONE FORMATION HUMAN HEALTH
5 FINE PARTICULATE MATTER
6 OZONE FORMATION TERRESTRIAL ECOSYSTEMS
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8 FRESHWATER EUTROPHICATION
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15 LAND USE
16 MINERAL RESOURCE SCARCITY
17 FOSSIL RESOURCE SCARCITY
18 WATER CONSUMPTION

4.2.3. Recommendations by product category

This section integrates conclusions from the meta-analysis of LCA studies, results from the screening LCAs and expert opinion to arrive at a ranking of the feedstock-product-country combinations under study. The analysis seeks to identify the more promising combinations to be considered for the next chapter, which addresses questions about scalability and economic viability.

The ranking must also be seen in the context of the objective of this study: to identify mostly biobased substitute materials that do not have end-of-life challenges similar to those of SUPs. As outlined before, if suitable waste management systems were in place, if use shifted from single to multiple uses, or if successful take-back schemes were in place, the ranking would be different. Table 4.3 has been developed taking the current and near-term scenarios into consideration and shows the alternatives that will be investigated further in the next chapter.

Table 4.3. Feedstocks to be considered further on the basis of environmental performance

Product	Country	Feedstock	Reason for inclusion
Grocery and other bags	Bangladesh	Paper, jute	Paper and jute are kept as LCA screenings show low environmental footprint profiles. Murta, banana pseudo-stem/leaves and sisal are kept as well due to expert judgment and because of local abundance. Screening LCAs were not possible due to a lack of data. Cotton is kept, even despite screening LCAs showing high environmental impacts. The meta-analysis of LCA studies indicate however acceptability.
		Murta and other reeds, banana pseudo-stem and leaves	
		Cotton	
	Kenya	Paper, jute	
		Sisal	
		Cotton-hemp	
	Nigeria	Paper, jute	
		Cotton-hemp	
Takeout/ takeaway containers and plates for food	Bangladesh	Paper or cardboard	Paper/cardboard is kept as LCA screenings show it has a small environmental footprint. Areca leaf, banana pseudo-stem and leaves, coconut husk and plantain leaves are kept as well because of local abundance. Coconut husk is also a material recommended by the Kenyan Bureau of Standards. Screening LCAs were not possible due to a lack of data.
		Banana pseudo-stem, areca leaf	
	Kenya	Paper or cardboard	
		Coconut husks	
	Nigeria	Paper or cardboard, plantain leaves	
Straws	Bangladesh	Paper, wheat stem	Paper and wheat stem are kept as LCA screenings show low environmental footprint profiles. Wheat stem is derived from post-harvest waste and will therefore have still lower impacts.
	Kenya		
	Nigeria		
Bottles	Bangladesh	Paper, wheat stem	Glass is kept despite screening LCAs showing large environmental impacts as no biobased alternatives are available. Both glass and aluminium are used already in the three countries, and take-back and recycling systems are also available. Screening LCA for aluminium was not possible for lack of data.
	Kenya		
	Nigeria		

Given the comparably worse environmental performance of wool, it is not further considered in the next chapter regarding SUP bag alternatives. Equally, the assessment showed relatively poor environmental performance for bamboo, and similar results are estimated to be applicable to wood-based items. Wheat is kept for straws, but it did not yield promising results for other SUP items. Coconut shells are used in Bangladesh to be mixed with bamboo and thus are not kept. Clay is not kept because pottery is breakable and cannot deliver the same functionality. Also, its scalability is doubtful as pottery-making skills are no longer abundant. Finally, the performance of stainless steel-based straws was significantly worse than the alternatives and thus it is not kept for further study in the next chapter.

4.3. Conclusion

Chapters 3 and 4 have addressed three major pieces closely linked with addressing the growing use and consequentially increasing pollution from four SUP product categories in three countries. The first part of this chapter discussed general reasons behind the growing pervasiveness of SUP products, such as high convenience at low cost and reasonable assurance of hygienic, leak-proof handling. Substitute feedstocks were identified that could help reduce end-of-life plastic pollution. Finally, alternative feedstocks were compared using information derived from a review of LCA studies as well as from screening LCAs, to assess their performance in multiple environmental impact categories. Conducting screening LCAs helped identify feedstocks with relatively better performance and reveal trade-offs across the impact categories. It also allowed consideration of the complete life cycle of the product from raw material extraction to end-of-life disposal. Taking all three parts of the chapter together, the following conclusions and recommendations were developed:

1. In general, SUP products offer a consumer experience that is not easily replicable by any alternative feedstock that is currently being used to make the four products under study. However, plastic pollution is a continuously growing global challenge that needs to be addressed and mitigated, and thus alternatives are needed urgently.
2. Apart from the obvious fact of increasing use of plastics, plastic pollution is attributable to two very different factors. One is the scientific fact that plastic products do not decompose under natural conditions and thereby contaminate the environment. The other is human mismanagement of plastic waste, which in turn is attributable to two simultaneous factors. The first is the relatively quick shift from using natural or durable materials to using SUP products in societies where consumer awareness of the need to discard SUP products responsibly – and consumer motivation to do so – has not developed as quickly as the shift occurred. The second is a lack of resources in those societies to set up systems and infrastructure for handling SUP waste where it is generated.
3. Policymakers recognize that such consumer awareness and motivation as well as infrastructure for handling plastic waste (such as industrial composting) may not materialize in many countries very soon. A pragmatic approach in such countries for the near term, and perhaps even the long term, could be to go back to alternative feedstocks (made from plant and animal products or metals and minerals). This would require new technological as well as design innovations to match the experience consumers already know with SUP products.
4. From an environmental performance perspective, however, such a move could also have significant environmental repercussions. Although natural products do not have the same end-of-life challenges as plastic, they use more resources such as land and water and their cultivation or extraction affects the environment adversely in many other ways as a result of agrochemical use or mining activity. In addition, during their decomposition stage they release considerable amounts of greenhouse gases, thereby contributing to climate change.
5. Out of the alternative feedstocks that are natural materials, the ones that are agricultural by-products or post-harvest agricultural waste could be more promising candidates as the impacts associated with their cultivation are significantly lower due to apportioning. They may even be net positive on account of the waste disposal impacts avoided. Yet the feedstocks that make durable products show promise only if a high number of uses are assured; otherwise, they end up being much worse for the environment than SUPs.

In sum, the plastic versus non-plastic and single- versus multiple-use debate is far from settled, although the immediate and very visible crisis of plastic litter on land and oceans around the world tips the scale in favour of non-plastics. From a broader perspective, however, it needs to be understood that plastic can continue to be the option favoured by consumers and might even be the more sustainable option, provided it can be managed well – not just in developed countries but across the globe.

Therefore, governments and relevant stakeholders should make significant efforts to enhance waste management infrastructure in the three case-study countries. To address plastic pollution in the short term, a shift towards selected alternative materials may be the way to go, at the cost of some other environmental impacts. Also important are campaigns for raising consumer awareness regarding reuse as a strategy to achieve the lowest environmental footprint, as highlighted by the conclusions from the LCA meta-studies as well as the screening LCAs. The technical feasibility and economic viability of scaling up the use of different natural materials to substantially replace SUPs will vary from region to region. The next chapter analyses these techno-economic aspects for the various plastic substitutes identified for the case-study countries.

CHAPTER 5. ECONOMIC ASSESSMENT OF PLASTICS SUBSTITUTES FOR SUB-SAHARAN AFRICA AND SOUTH ASIA

Based on the sustainability assessment of possible substitute materials for SUP products conducted in Chapter 4, this chapter analyses the techno-economic dimensions of the substitute materials identified. The overall objective is to assess the availability of the identified feedstocks in the respective markets, the technical infrastructure and the capability to produce products, as well as their economic viability.

To this end, the chapter assesses the situation country by country to provide a comprehensive overview of the situation in each. Within the four product categories under study, different products at times fulfil different purposes. For example, in this study, grocery bags under consideration are bags used to shop for pre-packaged products, and thus medium-sized bags are taken as the reference point. It is important to note that smaller plastic bags are also often used in the three countries to package meat, fish and loose items such as nuts, corn, berries and other small produce. Replacing these small bags with non-plastic alternatives for such uses will be a significantly greater challenge than doing so for medium-sized carry bags owing to hygiene and health implications. Such shifts should thus be looked into as part of future research but are outside the scope of this study.

Beyond these aspects, some products under study do not have large market shares (e.g. SUP plates, cutlery, straws) in the countries under study or possess particular characteristics that cannot be replaced by products based on other materials. This holds true for water sachets, for example: none of the alternative materials identified could replace plastic sachets in the markets under study. Instead, a totally different approach to offering similarly low-cost water access would be required. An example could be the countrywide installation of water fountains; however, they would require a significant change in consumer behaviour and thus do not truly represent an alternative material for sachets and their associated consumption patterns.

Finally, the feedstocks identified might have various use cases. Thus even if a feedstock is available in the market, it might not be available at competitive prices for the products under study. Political conditions in the countries under study, such as a ban on the usage of certain materials or policies that hamper the import of certain materials could affect conditions and will be considered as relevant factors in the assessment.

5.1. Bangladesh

5.1.1. Plastics

Except for some special packs, most SUP products widely available in Bangladesh are produced domestically. However, the raw materials – i.e. polyethylene, polystyrene, polypropylene and PET – are imported. Some SUP packaging also enters the country embedded with the imported product (e.g. drinks that come in sachets and other containers). More than 3,000 small-scale domestic businesses supply plastic products to domestic and international markets (Hossain, 2016). Despite the national ban on SUP bags, more than 200 factories in Dhaka alone manufacture polythene bags. Each factory has a daily production capacity of 500–700 tonnes of polythene bags of different categories (Bhuiyan and Sakib, 2020). The main customers for these polythene bags are kitchen market outlets, grocery shops and wholesale market traders.

5.1.2. Paper products

a. Domestic availability of feedstock to manufacturers

Table 5.1. Bangladesh: Average prices of selected SUP products

Polybag	**Glass**	**Large plate**	**Spoon**	**Spoon**	**PET bottle** 500 ml
BDT 1.5–2.5 ($0.02–0.03)	BDT 1 ($0.01)	BDT 9 ($0.11)	BDT 0.8 ($0.01)	BDT 0.4 ($0.005)	BDT 3.67 ($0.04)

Source: Market survey of retail prices by local partners, Light Castle Analytics Wing (2020).

Note: Thin handleless bag: BDT 260–380 ($3.07–4.50) per kg, thicker bag with handle: BDT 500–850 ($5.90–10.00) per kg. Bag weight: ~5.5g per bag (Leeuwen, 2013).

Unlike in the past, when the paper industry in Bangladesh used local raw materials – including softwood, bamboo and other fibres – it is becoming dependent on imported dry pulp, as well as local and imported waste paper. Raw-material prices have been on the rise: The cost of imported hardwood pulp went up to $810/tonne in 2017/18, from $470/tonne in 2015/16, and that of softwood pulp to $950/tonne from $500/tonne during the same periods.

b. Availability of manufacturing capacity

Demand for almost all types of paper, including packaging paper, art paper, newsprint and writing paper, far exceeds supply. Demand for packaging paper was estimated to be 5,000–6,000 tonnes/day, whereas local mills can produce only 1,455 tonnes/day. About 50,000 tonnes of packaging paper were imported through Chittagong and Benapole ports over the span of three months in the first half of 2018 (Uddin, 2018). Yet manufacturing capacity for paper products is available in the country, as can be seen from its export earnings from such products: in 2017/18, they reached $75–76 million, up 33.2 per cent from the previous year. Products exported include A3, A4 and legal-size paper; exercise books; industrial paper; and hygiene products such as toilet paper, paper napkins, facial tissues, pocket tissues, kitchen towels, paper towels, jumbo-roll tissue and clinical bed sheets.

In 2018, about 100 private paper mills were producing 1.5 Mt of paper per year (Uddin, 2018). Two of the three public sector paper mills, Khulna Newsprint Mill and Pakshi North Bengal Paper Mills, are now out of operation (Debnath, 2018), and Karnaphuli Paper Mills, the third and the largest mill in Bangladesh, is still limited in production owing to raw material scarcity and environmental issues. The larger companies import reconditioned machinery to save costs, but this affects product quality. The paper industry in Bangladesh has suffered heavy losses during the COVID-19 pandemic with the lockdown and the plunge in demand for writing and printing paper (Parvez, 2020).

c. Price competitiveness of end-use products

Table 5.2 shows price ranges for various paper products under study as compared with ranges for similar SUP products. Most of these prices were obtained from KPC Industry (2021), the largest manufacturer of paper cups and other products in Bangladesh. The price of plastic plates was obtained from a wholesale store in Dhaka and verified with a wholesaler from Chittagong.

Paper cups, plates and straws are expensive compared with plastic items. Paper cups are expensive in part because manufacturers in Bangladesh have to pay a total of 61 per cent of combined tax and duty on import of raw materials (Parvez, 2017). However, with the advent of food home delivery due to the pandemic, the industry has an opportunity to increase scale and lower prices. The annual consumption of single-use cups is estimated at 120–150 million pieces (Parvez, 2017 and Ovi, 2017), but the use of paper cups is very low, owing to a lack of consumer awareness, product availability and price sensitivity (Ovi, 2017).

d. Conclusion

In Bangladesh, paper stands a good chance of achieving scalability and price parity with SUP alternatives for specific uses. Although paper bags, cups, plates, and food/beverage boxes (with plastic lamination for beverages and wet food boxes) are available in Bangladesh, adoption is high only for brown handleless paper bags (or rather envelopes) of varying size used to pack dry grocery items, which are in turn carried in plastic or jute grocery bags. Local small-scale producers use both fresh and wastepaper to manufacture such items. In addition, paper recycling is a mature industry, so collection and recycling are also possible.

Table 5.2. Bangladesh: Comparison of prices for paper- and plastic-based products

Product	Paper	Plastic
Grocery bag	BDT 5 ($0.06) (handleless)	BDT 1.5 ($0.02) (handleless)
Cups	BDT 2 ($0.02)	BDT 1 ($0.01)
Plate	BDT 5–5.5 ($0.06) (bulk purchase) (300 g/m^2)	BDT 4.5 ($0.05) (medium) BDT 9 ($0.11) (large)
Straw	BDT 1.7 ($0.02)	BDT 0.4 ($0.005)

Source: KPC Industry (2021), Dhaka wholesale store and Chittagong wholesaler.

5.1.3. Jute

a. Domestic availability of feedstock to manufacturers

Bangladesh is the second largest producer and exporter of jute, accounting for about 42 per cent of global production in 2018-19 with a yield of 8,576,087 bales – about 1.56 Mt (Bangladesh Bureau of Statistics, 2021). Compared with India and Pakistan, the two other significant consumers, Bangladesh showed the most notable rate of growth in consumption from 2007 to 2018 (GlobalTrade, 2019).

b. Availability of manufacturing capacity

The Jute Diversification Promotion Centre under the Ministry of Textiles and Jute lists 256 products made from jute, ranging from bags, fabrics and artwork to tea (Jute Diversification Promotion Centre, 2021). The Mandatory Jute Packaging Act, 2010 and Mandatory Jute Packaging Rules, 2013 aim to replace SUP packaging with jute packaging for 19 agricultural commodities in Bangladesh (Dhaka Tribune, 2018). Other than for packaging agricultural commodities, jute carry bags in their current form are a niche item). There is no shortage of manufacturing capacity for jute items in Bangladesh, but the industry needs innovation and modernization to compete with plastic packaging. One example is a biopolymer-based product called a "Sonali bag" recently developed by the research wing of the Bangladesh Jute Mills Corporation g (Bangladesh Jute Mills Corporation, 2021b).

c. Price competitiveness of end-use products

Jute grocery bags cost about BDT 125–250 ($1.47–2.95) when destined for export and BDT 10–90 ($0.12–1.06) for the domestic market, making them significantly more expensive than plastic bags, which cost BDT 2 ($0.024). The export price of jute bags was obtained from ApparelLink BD (2021) and the local price from Kohinur Trading World (2021). For ordinary use and domestic consumption, much less expensive products need to be placed in the market.

d. Conclusion

Bangladesh has been a world leader in the jute industry, and jute presents a readily available option for replacing manufactured materials with natural ones. To carry packaged groceries, jute is a viable option. Consumers are much more likely to reuse a jute bag for carrying their shopping than some other options, especially plastic. Still, replacing the wide range of uses of plastic bags with the jute products that are currently available will be a challenge. For example, jute bags are relatively heavy and also not suitable for carrying moist materials. This means a wide range of SUP bags (handleless small-size bags, sachets, and so on) will continue to be used along with jute bags.

5.1.4. Cotton and "jhoot"

a. Domestic availability of feedstock to manufacturers

In 2019, Bangladesh had a 6.8 per cent share of global garment exports, ranking third after China and the European Union, and almost double the share of India (3.5 per cent) (Statista, 2021). Nearly 80 per cent of the garments are made from cotton, with the rest made viscose, polyester and other materials. The high demand for raw cotton is met mainly from imports, partly from local production and a small but increasing amount from recycling. Cotton produced in Bangladesh consists of two types: American Upland cotton (Gossypium hirsutum) and Tree cotton (Gossypium arboreum). Raw cotton production in 2020/21 is estimated at 146,000 bales, which is slightly higher than the previous year, and imports are forecast to rebound to 7 million bales (Global Agricultural Information Network, 2020). With the huge cotton garment export industry, a typical Bangladeshi factory produces about 250–300 kg of waste fabric per day.

Bangladesh churns out 351,000 tonnes of by-products of ready-made garments per year, mostly scrap fabric (known as "jhoot" in the local language) in the form of cut pieces and other scrap fabric (Khan, 2020; Hossain, 2019). Locally, jhoot is used for making garments for children, mattresses, pillows, cushions, and seat stuffing and padding for cars, buses and rickshaws. It is also a source of fuel for industrial boilers and for heating bitumen in road construction. At toilets in many mosques, smaller pieces of jhoot are used as a cheap alternative to tissue. Exported jhoot is recycled into yarn for fresh fabric. With so much jhoot available, it makes no sense to produce cotton fabric to make bags to replace medium-sized shopping bags; however, bags could be made from jhoot both as a stylish reusable accessory and a thin single-use bag.

b. Availability of manufacturing capacity

Historically, Bangladesh was known across the world for its fine muslin. Today, it has 433 spinning mills, 796 textile weaving mills, and 246 dyeing and finishing mills, as well as 6,502 registered and 527 unregistered garment and textile factories. Cotton-based spinning and textile making is a major industry in Bangladesh for which the global supply chain is mature, the technology is known, capable entrepreneurs exist and financing is easy. As such, Bangladesh is well equipped to make anything from cotton or jhoot, not only for domestic use, but for exporting as well.

c. Price competitiveness of end-use products

A typical grocery bag (30.48 x 33.65 cm, 90 g/m2) made of cotton canvas costs about BDT 35 ($0.41). Cotton bags are also being offered for free with shopping by at least one department store chain (Agora) in Bangladesh. These bags are lightweight and thin, and the price is estimated to be BDT 10 ($0.12), according to interviews with local stakeholders. The price of jhoot depends on its quality and size, starting from BDT 10 ($0.12) and going up to BDT 300/kg ($3.54/kg) (Khan, 2020). Assuming the weight of a typical cotton bag is 183.11 g/m2 (Edwards and Meyhoff Fry, 2011), the raw-material cost could be anywhere upward of BDT 1.83 ($0.02), depending on quality and type of material used.

d. Conclusion

Cotton bags are not popular because of their high price and scarcity in the local market. Non-woven bags are comparatively much more popular and are replacing paper bags in shopping malls. In many ways, cotton bags in Bangladesh have the same advantages and disadvantages as jute: a mature industry with a glorious past, the suitability of the bags for limited items and the positioning of currently available bags as expensive luxury items (also exported). However, the potential for mass use definitely exists, especially with jhoot and lightweight fabric as raw material. The current ban on SUP bags coupled with product innovation could turn thin and lightweight cotton and jhoot bags into affordable, throwaway alternatives.

5.1.5. Banana pseudo-stem and leaves

a. Domestic availability of feedstock to manufacturers

Banana leaves are traditional packing materials for some items, and on a limited scale pieces of leaves are used as single-use plates or wraps for food items such as cooked rice and fish. Banana fibre can be used to make yarn, fabric, apparel, handicrafts, paper, currency notes, security printing paper, craft paper and plywood (Sobhan, 2014). About 200 grams (g) yarn can be extracted from the stalk of one tree (Jago News Desk, 2018).

In the face of the insatiable appetite for fabric to feed the garment export industry, Bangladesh is exploring the benefits of using banana pseudo-stem to yield fibre, all the more so because it comes from agricultural waste left over after harvesting the fruit. In 2018/19, estimates placed the potential availability of fibre made from banana stalks at 33,706 tonnes, in light of the 48,849 ha under banana cultivation (Bangladesh Bureau of Statistics, 2020a) and a fibre yield of 690 kg/ha (Sobhan, 2014). As for banana leaves, 2016/17 estimates place availability at 1.48 billion pieces per year (Bangladesh Bureau of Statistics, 2020a).

b. Availability of manufacturing capacity

The banana fibre industry in Bangladesh is nascent, very much small scale and without organized guidance or government support. Yet, with millions of tons of banana pseudo-stem being disposed of as waste, the potential to mainstream its use to make low-cost products to replace SUP bags and food boxes remains high, from both environmental and economic perspectives. Some of the challenges are technological; some relate to innovation, supply chain/sourcing and transportation of raw materials. As for banana leaves, apart from washing to ensure hygiene and cutting for shape and size, their use as wraps or serving plates requires no processing.

c. Price competitiveness of end-use products

The price of banana fibre is estimated at BDT 130/kg ($1.53/kg); another estimate puts the price of a banana tree at BDT 75 ($0.88), with 8–10 trees yielding 1 kg of fibre (Sobhan, 2014). Although they cannot be compared directly, the fibre price looks favourable relative to the plastic for SUP bags, which sell for BDT 180/kg ($2.12/kg). As banana fibre is a post-harvest waste item, there are no production costs for the tree itself and the main raw-material cost is attributed to transportation of the material from plantations to fibre extraction facilities (Mohiuddin et al., 2014).

d. Conclusion

Banana is cultivated all over Bangladesh, and the banana pseudo-stem is mostly disposed of as waste, by composting or by using it as fuel. Banana leaves are already used for traditional foods, and now it is in fact a question of stopping their replacement by SUP items. The potential to mainstream the use of pseudo-stem as an industry to make low-cost products to replace SUP bags and food boxes in Bangladesh is relatively high. Some of the challenges to overcome are technological; some relate to innovation, supply chain and sourcing and transportation of raw materials.

5.1.6. Murta

a. Domestic availability of feedstock to manufacturers

Murta is a wetland reed that grows in abundance in Bangladesh. Its production in 2019 was estimated at 0.9 million plants per year (Forest Department, Bangladesh, 2019).

b. Availability of manufacturing capacity

Making useful items from murta has been an age-old cottage industry in Bangladesh. The best-known item is shitalpati, a cool mat that is used in rural areas for sitting or sleeping. Because of its aesthetic appeal, the mat and other items made from murta are now finding their way into urban homes as well. The use of murta to replace SUPs is mainly in the form of baskets to serve as carry bags.

c. Price competitiveness of end-use products

Novelty items made from murta are not suitable for price comparisons with SUP items. One cool mat, which could be the equivalent in volume of 10 baskets, is currently priced at BDT 400–1,500 ($4.72–17.70) depending on design, pattern and finishing. Going by these prices, a plain, daily-use murta basket could potentially be available for less than BDT 40 ($0.47).

d. Conclusion

Some specific SUP bags can be replaced with reusable baskets made from murta (or other reeds available locally). However, reeds are heavy and thus baskets made from them are suitable for carrying a limited set of items. Unlike murta, other reed products are low value, but available in specific areas only.

5.1.7. Areca leaves

a. Domestic availability of feedstock to manufacturers

Arecanut trees grow widely in Bangladesh. About 1,437 arecanut trees can grow in a hectare (Naik, 2013). The main yield from the tree is the edible nut, which is used as an ingredient in a local preparation; the leaf is a by-product. Information sourced from Bright Areca Ltd. (2021) indicates that an adult tree has 7–12 open leaves, each with a sheath – i.e. 9 leaves per tree – from which the yield of areca leaves as feedstock is 10 per cent. With an area of 386,957 ha under areca cultivation in 2019 (Forest Department, Bangladesh 2019), the number of leaves available was estimated at 501 million.

b. Availability of manufacturing capacity

Making products from areca leaves is a cottage industry in Bangladesh. The leaves have been used as material to create shades in betel leaf fields, natural screen over fencing around homes, even as a tool for children to play with and as fuel. A few start-ups are making food containers from areca leaf, but the technology is not very sophisticated. Local manufacturers can make the machines currently used in the areca leaf products industry, but these machines are slow and the finishing of the end product is nevertheless done completely manually. An automated set-up would be needed to achieve large-scale production and a consequent reduction in prices through economies of scale.

c. Price competitiveness of end-use products

The price of areca food containers ranges from BDT 5 to BDT 20 ($0.06–0.24) per piece, depending on the item and its size. Prices were obtained from Bright Areca Ltd. (2021). Single-use plates and bowls made by the leaf are priced at BDT 15–20 ($0.18–0.24), according to a television advertisement (Amin TV, 2020). These prices do not compare favourably with SUP items yet. This situation is similar to that of cotton, jute and other materials that are still considered niche rather than mainstream items.

d. Conclusion

Areca leaf products can be a useful alternative to single-use plates and food boxes for dry items. However, capital investment, product innovation and marketing inputs need to be strengthened.

5.1.8. Bamboo

a. Domestic availability of feedstock to manufacturers

Bamboo grows all over Bangladesh, naturally and under cultivation. The harvest from reserve forests alone was stated to amount to 49,875,936 pieces in 2018/19 (Forest Department, Bangladesh, 2019).

b. Availability of manufacturing capacity

Bamboo is mainly used as material for construction and making furniture. The making of products such as plates or cutlery from bamboo is a cottage industry, and they are more often fancy items rather than daily-use items. The exception is drinking straws, which are reported to be widely used and manufactured in hilly regions of the country (Environment and Social Development Organization, 2019). They can be made from bamboo branches with little processing.

c. Price competitiveness of end-use products

Prices for bamboo straws produced for domestic use could not be ascertained. They are estimated to be competitive, given the wide availability of the material and the insignificant labour cost to make them.

d. Conclusion

Given the abundance and low cost of bamboo, it could be a good alternative to SUP straws in Bangladesh.

5.1.9. Glass

a. Domestic availability of feedstock to manufacturers

Bangladesh had a mature glass bottle industry that has been severely downsized by the popularity of SUPs, with few survivors. Glass has traditionally been used for varied needs, ranging from kitchenware to windows in buildings. As for glass bottles, current uses include pharmaceutical bottles and bottles for liquids for which plastic is not the preferred material in Bangladesh – e.g. olive oil, pickles, honey.

b. Availability of manufacturing capacity

In 2018/19 glass sheet manufacturing capacity was stated to be 9,305.56 Mt and production was 7,123.77 Mt (Usmania Glass Sheet Factory Ltd, 2020). Bengal Glass Works (2021) has a manufacturing capacity of 400 million bottles per year. Data for 2009 place the manufacturing capacity of two local companies at 100–120 tonnes/ day (ITC, 2009).

c. Price competitiveness of end-use products

The cost of glass bottles in Bangladesh ranges from BDT 10 to BDT 400 ($0.12–4.72) and stands no comparison with PET bottles, which are available for BDT 3–13 ($0.035–0.15). These prices were obtained from wholesalers of PET bottles in Dhaka and Chittagong. However, price alone is not a fair comparison, considering the reusability of glass bottles.

d. Take-back schemes

Previously bottlers and distributors of Pepsi, Coca-Cola and similar beverages had strong take-back and reuse systems, but currently no producer has such a scheme. Most glass recycling happens through informal collection by waste pickers.

e. Conclusion

Before the introduction of single-use PET bottles, reusable glass bottles were in common use under an effective collection mechanism. Therefore, it is considered possible to tap into that experience with product marketing and technical know-how to return to using glass bottles as a partial replacement for SUP bottles.

5.1.10. Aluminium

a. Domestic availability of feedstock to manufacturers

In 2018/19, Bangladesh imported 163,330.78 Mt of aluminium (Bangladesh Bureau of Statistics, 2020b). The number of cans imported is reported to be 57.6 million per year (with 28.8 million pieces imported by Transcom Beverages Ltd. (2021), which distributes Pepsi and allied beverage brands in Bangladesh, and an equal number assumed to be imported by the local distributor of Coca-Cola).

b. Availability of manufacturing capacity

Currently aluminium is used for kitchen utensils and cookware, window frames, furniture and cables. indicating some manufacturing capability. One canning company, Vita Cans (2021), is operational in Bangladesh and lists beverage canning as one of its offerings.

c. Price competitiveness of end-use products

The price of aluminium in Bangladesh ranges from

$1,700 to $2,000/tonne (Merchant Message Desk, 2020). No data are available for the price of an empty can.

d. Take-back schemes

No formalized take-back scheme exists for aluminium cans in Bangladesh. Nonetheless, almost all aluminium cans and utensils and similar products (except aluminium foil) are recycled, through both formal and informal channels (UNDP, 2019).

e. Conclusion

Aluminium cans for beverages can be a viable option because if beverages are available in cans, the empty ones are almost certain to be recycled. However, such cans cannot be used water.

5.2. Kenya

5.2.1. Plastics

Oil production in Kenya is relatively recent, with the Turkana Oil reserves currently being exploited at only a slow rate (Wa-Kyendo, 2020). A refinery operated at Mombasa port until 2013, when it was shut down (EIA, 2016). The lack of availability of raw material makes Kenya a net importer of plastic in its primary form, with more than 419,000 tonnes imported in 2018 (United Nations, 2021). The plastic industry is well developed: more than 300 formal establishments manufacture bottles, packaging bags, household wares and containers, crates, shoes, PVC pipes and fittings, and floor tiles. The approximately 100 companies that are members of the Kenya Association of Manufacturers have a combined installed production capacity of 360,000 tonnes of plastic products per year (KAM, 2018).

Table 5.3 shows the average prices of plastic products for end-consumers in Kenya. Prices were obtained directly from supermarkets in Kenya. Variations are due to recent increases in oil prices in Kenya. The lower price is at wholesale, and the higher price is for a single piece.

5.2.2. Paper products

Table 5.3. Kenya: Average prices of plastic products

Plate medium, plain	**Grocery bag** medium	**Straw**	**PET bottle** 1,250 ml
K Sh 10–15 ($0.09–0.14)	K Sh 5–25 ($0.05–0.23)	K Sh 3–5 ($0.03–0.05)	K Sh 2–4 ($0.02–0.04)

Source: Based on prices in supermarkets in Kenya.

a. Domestic availability of feedstock to manufacturers

Currently, domestic production of pulp is marginal. In 1970, the Government started a joint company with Orient Paper Mills of India and Pan African Paper Mills (E.A.) Ltd., commonly known as PanPaper. This company oversaw the main activity of pulp and paper production in Kenya until its decline in 2009 and later privatization in 2016 (Ochieng Otieno et al., 2020). The production of pulp in Kenya has also declined and is currently trying to recover through private investment. However, the paper and paper products industry has not shut down. Companies source raw material from abroad. For example, they imported sulfate chemical pulp worth more than $1.2 million in 2018 (United Nations, 2021).

b. Availability of manufacturing capacity

More than 100 companies convert paper to end-consumer products, among them manufacturers of paper bags. Given the ban on plastic bags outlined in chapter 2, the market for paper bags and sacks in Kenya is growing; in 2018 demand was expected to reach 40,000 tonnes (KAM, 2018).

c. Price competitiveness of end-use products

Table 5.4 shows a comparison of paper and plastic products for end users, according to Jumia (2021). The plastic and paper options are in the same price range.

d. Conclusion

Paper products are viable alternatives to replace plastic products, as the feedstock is available and there are multiple manufacturers in the country.

Table 5.4. Kenya: Comparison of prices of paper- and plastic-based products

Product	Paper	Plastic
Plate, medium-size, plain	K Sh 6–10 ($0.06–0.09)	K Sh 10–15 ($0.09–0.14)
Shopping bag, medium-size	K Sh 4–20 ($0.04–0.19)	K Sh 5–25 ($0.05–0.23)
Drinking straw	K Sh 2–5 ($0.02–0.05)	K Sh 3–5 ($0.03–0.05)

Source: Based on Jumia (2021).

5.2.3. Jute

a. Domestic availability of feedstock to manufacturers

Jute is produced in Kenya at low rates. Some climatic aspects may be influencing the viability of the crop, making it more challenging to grow than other soft fibres (Peeler, 1967). Despite this, due to the low number of jute-producing countries, Kenya has consolidated a position as one of the world's top five jute exporters, with total exports of 8,787 tonnes in 2018, generating a value of $1,572/tonne, the highest price in the export market (GlobalTrade, 2019).

b. Availability of manufacturing capacity

Jute bag manufacturers, such as Mece General Trading Limited, are present in Kenya mainly to produce packaging for agricultural products, but jute bags are also imported from countries such as Bangladesh. Several shopping bag manufacturers were identified during the market research; however, their production capacity could not be ascertained.

c. Price competitiveness of end-use products

Prices of jute bags vary; the lowest price found during the market research was K Sh 750 ($6.90) (Green Initiatives Kenya, 2021), making this option far less likely to be considered by consumers. When the ban on plastic bags was imposed, people chose to carry buckets from home instead of purchasing reusable alternatives to plastic bags because of the high costs of those alternatives (Deutsche Welle, 2018).

d. Conclusion

Although jute is produced in Kenya, the high profitability of export activities implies that the raw material is not widely used in the country. Jute shopping bags are considered too expensive by consumers and are not a viable alternative.

5.2.4. Cotton

a. Domestic availability of feedstock to manufacturers

Nowadays, Kenya is a net importer of cotton, which is used to produce textiles for export. Cotton cultivation in Kenya is undertaken by approximately 40,000 smallholder farmers (on an average of 1 ha each), a small count compared with the 200,000 producers the country had in the 1980s (KAM, 2018). In 2018, out of the 24 installed ginneries, only about 10 were operational (KAM, 2018), with a total production of approximately 4,700 tonnes of cotton per year (USAID, 2018). Something similar is observed for the yarn and fabric production steps in the value chain: only 15 of the 52 registered yarn mills are operating, with low productivity rates of between 40 and 50 per cent of installed capacity (KAM, 2018). The decline in the cotton industry was due to the termination of governmental market control policies, a decline in international donor support and an import ban imposed by the United States in 1994 (Gitonga et al., 2009). Several stakeholders are pushing to renew the cotton industry in Kenya. The Cotton Development Authority estimates that potential exists to expand the cultivated area to 350,000 ha with overall production of 50,000 tonnes/year (Gitonga et al., 2009).

b. Availability of manufacturing capacity

Several manufacturers of cotton bags were identified in Kenya during the market research; however, it was not possible to establish the production capacity of the country as a whole. The textile and apparel industry in Kenya focuses on the export market for products such as trousers, slacks, shorts, knit shirts and blouses as a result of favourable conditions under the African Growth and Opportunity Act. The Act grants Kenya quota- and duty-free access to United States markets, which has elevated exports from $8.5 million in 2000 to $322 million in 2014 (World Bank Group, 2015).

c. Price competitiveness of end-use products

The price of ordinary cotton bags (not high-end bags) is K Sh 100 to K Sh 250 ($0.93–2.32), making them significantly more expensive than available alternatives.

d. Conclusion

Cotton production is at low levels in Kenya, but there are plans to increase production towards 2030. Currently, cotton bags are not an alternative for carrying groceries because of their high prices, caused mainly by the reliance on imports of raw material.

5.2.5. Sisal

a. Domestic availability of feedstock to manufacturers

Kenya is among the top five sisal producers in the world. In 2015, production in Kenya met 10.4 per cent of the world's total demand. Of the 25,000 tonnes, nearly 20,300 tonnes were exported, mainly to Saudi Arabia, Nigeria, Morocco, Spain and Egypt for use in the construction industry (FAO, 2019). That leaves more than 4,000 tonnes of sisal fibre available for domestic use each year.

b. Availability of manufacturing capacity

Sisal is already heavily used in Kenya, but capacity has not yet been developed to produce fine textiles, even though the technology is available (Fashion Revolution, 2020). During market research, one producer identified was Premier Bag and Cordage Ltd, with a production capacity of 300 tonnes/month.

c. Price competitiveness of end-use products

The unitary price of sisal shopping bags is K Sh 300 to K Sh 500 ($2.79–4.65), according to market research, which makes them not a viable economic alternative.

d. Conclusion

Sisal fibre and sisal bag manufacturers are available in Kenya, but the relatively high price hampers the spread of this alternative for carrying groceries.

5.2.6. Wheat stems

a. Domestic availability of feedstock to manufacturers

Wheat produced in Kenya satisfies one third of the country's demand. The rest of the crop needed is sourced through imports from the Black Sea region, mainly from the Russian Federation, Ukraine and Kazakhstan (ITA, 2020). Currently, stems and stalks from wheat harvested in Kenya are discarded without any value added (KALRO, 2016).

b. Availability of manufacturing capacity

Wheat-based straws do not require any manufacturing capacity.

c. Price competitiveness of end-use products

The price of drinking straws made of wheat stems has high variations depending on the origin of the product. For imported wheat straw, the cost can be as high as K Sh 29 ($0.27) per piece. For domestic products, the price can be as low as K Sh 5 ($0.05) per piece, making it a competitive option against plastic straws, which cost K Sh 2–4 ($0.02–0.04).

d. Conclusion

The domestic availability of raw material, low manufacturing requirements and low prices make wheat straws an excellent option for replacing plastic straws.

5.2.7. Glass

a. Domestic availability of feedstock to manufacturers

Silica mining activities began in the mid-1980s in Kwale, but the silica sand extraction industry is not well established and few regulations and policies are in place. Recently, the Msambweni Sand & Stone cooperative society was formed to help address the needs of the local mine owners. Silica sand is sold and transported to Mombasa or Nairobi counties for further processing (Nyaega, 2014).

b. Availability of manufacturing capacity

There are two leading manufacturers of glass bottles in Kenya: Central Glass Industries and Milly Glass. Central Glass Industries is a subsidiary of East African Breweries, and Milly Glass, based in Mombasa, supplies mainly Coca-Cola (JICA, 2012).

c. Price competitiveness of end-use products

The price of glass bottles is about K Sh 10–20 ($0.09–0.19).

d. Take-back and recycling schemes

A deposit refund system is in place for returning glass beverage bottles from consumers to retailers. Under the system, the consumer pays a deposit for reusable glass bottles that is refunded upon return of the bottles. The deposit ranges between K Sh 10 and K Sh 25 ($0.09–0.23) for soft drinks and beer bottles, respectively. This system has been widely accepted because of the ease of administration, which involves several stakeholders (Ikiara et al., 2004). The scheme is managed by the market-leading brewery (KAM, 2019).

The formal recycling market is dominated by one company located on the coast. This company buys waste glass from all over the country. However, recycling is mainly open loop, with the secondary material (shredded glass) used as fill in construction works (KAM, 2019).

e. Conclusion

Glass bottles are an effective alternative under a take-back scheme in which the bottles are returned to the company for reuse, and their use could be scaled up to replace SUP bottles.

5.2.8. Aluminium

a. Domestic availability of feedstock to manufacturers

Bauxite is the raw material needed to produce aluminium. As there is no bauxite production in Kenya, 60 per cent of the raw material for the aluminium industry is imported. The rest is recovered as scrap and recycled within the country (Weramwanja, 2010).

b. Availability of manufacturing capacity

Aluminium cans are produced in Kenya for soft drink packaging. No data on manufacturing capacity were available during the market research.

c. Price competitiveness of end-use products

Prices of PET bottles and aluminium cans are difficult to compare, given that aluminium cans are predominantly used for soft drinks, whereas PET bottles are also used for water. Manufacturing prices for aluminium cans could not be established; however, aluminium can companies have been operating in Kenya for several years, with growing demand and acceptance from the public, suggesting the existence of a profitable domestic market.

d. Conclusion

The beverage can industry has been operating well in the country and has the capacity to meet current domestic market needs. As such, aluminium cans represent a viable alternative to replace PET bottles.

5.2.9. Hemp

a. Domestic availability of feedstock to manufacturers

Using hemp fibre to manufacture textiles is not a new endeavour. In the 19th century, East Asian people wore bark cloth made from fibres such as linen, hemp, banana and palm, all deriving from the bast or outer layers of the plant stems (Wanduara, 2018).

Industrial hemp cultivation is illegal in Kenya because it is mistakenly linked to the intoxicating effects of the cannabis plant (Fashion Revolution, 2020). Despite the prohibition, a limited commercial trade exists, with small quantities of true hemp fibre tow imported from the United Republic of Tanzania and South Africa and exported to the Sudan (United Nations, 2021). One supplier was found in the market, selling hemp fibre at $1,450/tonne (approximately K Sh 150/kg) (Fibre2Fashion, 2021).

b. Availability of manufacturing capacity

Although no manufacturers of hemp bags were found in Kenya, manufacturing capacity for textiles in general is available. Hemp could become a valuable alternative for the textile industry thanks to the climatic conditions of the country and hemp's benefits for soil conservation. Hemp fibres could be used for manufacturing textiles, paper, bedding materials, absorbents, particleboard, building materials (ceiling panels) and clothing (Fashion Revolution, 2020; Koyclothing, 2021).

c. Price competitiveness of end-use products

No prices for hemp bags were found for the Kenyan market.

d. Conclusion

Although hemp fibre is not related to the cannabis plant, it has a bad reputation in Kenya and its cultivation is illegal. Yet, some fibre is imported. Hemp has potential as an alternative feedstock thanks to its versatility.

5.2.10. Coconut husks

a. Domestic availability of feedstock to manufacturers

In 2018, Kenya produced 92,560 tonnes of coconut from 82,921 ha under cultivation, the majority in the coastal counties of Kwale and Kilifi. The crop accounts for 1.5 per cent of the total agricultural production of Kenya and 0.4 per cent of Kenyan gross domestic product, providing a livelihood for almost 100,000 farmers. However, the productivity of coconut farming in Kenya is low, a result of poor agricultural practices (Viffa Consult, 2020).

b. Availability of manufacturing capacity

No manufacturing capacity was found for producing plates out of coconut husks; however, the Government considers coconut husks a potential alternative feedstock for disposable dishes (Ministry of Environment and Forestry, Kenya, 2019b). Most coconut husks are thrown away or used as fuel by farmers unaware of their potential value. A start-up company in Kenya is using coconut husks to obtain peat, an added-value by-product used as a horticultural growing medium (Unleash, 2021). In addition, coconut husks have been evaluated as feedstock for producing biomass briquettes as an energy source (Siemens, 2017).

c. Price competitiveness of end-use products

As coconut husk is currently considered waste and not turned into a commercial product, assessing its economic viability is difficult. In a study conducted by Siemens (2017), a coconut processing company reported that it was willing to sell the husks at K Sh 3/kg ($0.03/kg), and that they had an excess of 150 tonnes/month, which would indicate a cheap price for the material. However, the sanitization process may increase the costs of production and the final price of a coconut husk-based plate.

d. Conclusion

As there is no manufacturing capacity for plates made from coconut husks in Kenya, this alternative does not seem to be a good fit for replacing SUP plates. Nonetheless, the country is implementing measures to boost its coconut industry, and the feedstock could become a viable alternative in the short term.

5.3. Nigeria

5.3.1. Plastics

Plastic products are both imported and produced domestically. Despite having developed and grown a domestic plastic industry, Nigeria remains a major importer of plastics, with 70 per cent of raw materials imported and only 30 per cent produced domestically (Obioha, 2019). Throughout the last two decades, import volumes have continually risen; a study by the Heinrich Böll Foundation (Fuhr and Franklin, 2020) estimates that importation and consumption of plastics will reach over 40 Mt by 2030. Current data are not available, but the number of plastic-producing companies is estimated to have doubled since 2013, when there were more than 3,000 companies with a production capacity of over 100,000 tonnes/year.

Table 5.5 shows price ranges based on consumer end-prices for the various products under study. Prices were determined on the basis of listings on online platforms such as Jumia (2021), Supermart (2021) and Konga (2021) for batches of 100 products and converted to a price per unit. In addition, prices advertised by plastic product producers such as Plastic Store NG (2021) or other retailers like Dowins (2021) were taken into account to determine reasonable price ranges for the products under study.

5.3.2. Paper products

a. Domestic availability of feedstock to manufacturers

Nigeria was Africa's largest wood producer in the 1960s, but since then the nation's forest industry, and especially the paper subsector, has essentially vanished. This is mostly due to a complete lack of domestically available long-fibre plant resources, chemicals and other inputs needed for paper production. As a result, of the three paper mills that the Nigerian Government established in the 1970s, only one is still operating (Ezeudu et al., 2019).

According to investigations conducted by Alfred Olufemi (2020), the Jebba paper mill is the only remaining active mill, albeit operating well below capacity and processing only recycled paper due to lack of access to long-fibre plant material. A study conducted by Udohitinah and Oluwadare (2011) identified fibres from the kenaf plant as a potential alternative to long-fibre pulp for Nigerian pulp and paper mills. Yet even though the technology to convert kenaf fibres into a source material exists in

Table 5.5. Nigeria: Average prices of plastic products

Lunch box medium, plain	**Grocery bag** medium	**Plate**	**Straw**	**PET bottle** 250 ml	**Sachet**
NGN 45–85 ($0.11–0.21)	NGN 30–70 ($0.07–0.17)	NGN 40–55 ($0.1–0.13)	NGN 25–30 ($0.06–0.07)	NGN 100–140 ($0.24–0.34)	NGN 70–80 ($0.17–0.19)

Sources: Based on information from Jumia (2021), Supermart (2021), Konga (2021), Plastic Store NG (2021) and Dowins (2021).

the country, nothing has happened so far. Instead, Nigeria remains highly dependent on imports of paper. According to the UN Comtrade database, in 2019 Nigerian imports of paper and paperboard, and articles of pulp, paper and board had a total value of $458.25 million (United Nations, 2021).

The high dependence on imports results in various challenges for domestic manufacturers of paper products. They not only are affected by global prices, but also risk losing access to raw material altogether or being affected by long delivery times from paper mills in Europe or the United States (Olufemi, 2020).

b. Availability of manufacturing capacity

In view of the lack of local paper, domestic start-ups such as The Paper Packing Company have resorted to importing paper to then produce paper-based alternatives to SUP products, such as takeaway food containers, paper bags, paper cups and even paper straws. Manufacturing of these products is straightforward and does not require highly specialized technology. Since its launch in 2015, The Paper Packing Company has produced more than 12 million paper-based packaging alternatives and other companies have followed suit and started to produce similar products (Ugwuede, 2020).

c. Price competitiveness of end-use products

For the prices of paper-based products, prices were compared for lunch boxes and shopping bags made by producers The Paper Packing Company (2021) and Ebees (2021), as well as reseller Hotpack (2021) and online platform Jumia (2021). As shown in Table 5.6, plastic-based options are nearly half the price of paper-based options. As such, paper-based products are currently not economically competitive for replacing the SUP products under study. The main cost drivers for paper-based products seem to lie in the material sourcing phase. Because paper needs to be imported, it may be not only subject to high price fluctuations caused by global demand but also unavailable for certain uses owing to competition for imported paper in the market. In addition, the Chartered Institute of Professional Printers of Nigeria recently warned that a price rise of 300 per cent in the cost of paper far exceeded that of foreign exchange and was caused by the monopolization of the paper import industry by a select few stakeholders (Olufemi, 2021).

Table 5.6. Nigeria: Comparison of prices of paper- and plastic-based products

Product	Paper	Plastic
Lunch box, medium, plain	NGN 120–190 ($0.29–0.46)	NGN 45–85 ($0.11–0.21)
Shopping bag, medium	NGN 160–190 ($0.39–0.46)	NGN 30–75 ($0.07–0.18)

Sources: Based on information from The Paper Packing Company (2021), Ebees (2021), Hotpack (2021) and Jumia (2021).

d. Conclusion

The paper industry seems to be struggling in Nigeria, in terms of raw-material availability as well as processing capability. With this reliance on paper imports, it is unlikely that paper-based products could be scaled up to fully replace SUP products without significant investment and policy interventions.

5.3.3. Jute

a. Domestic availability of feedstock to manufacturers

Similar to the situation in the paper industry, a national initiative to produce large jute bags collapsed in about 1971 (Ibirogba, 2020). It was run by the Nigeria Fibre Company and Nigeria Fibre Production Limited. Studies cite a plant popularly called “ewedu” in Western Nigeria as a domestic resource option (Iheukwumere et al., 2020), and others have recommended use of kenaf (Oloruntoba et al., 2015; Akubueze et al., 2014). Despite an estimated demand for at least 5 million large jute bags in the country, no local production is in place. As a result, jute bags with a total annual value of ₦2.78 billion ($2.75 million) are imported to package agricultural commodities (Ibirogba, 2020).

b. Availability of manufacturing capacity

The lack of a domestic jute industry has caused significant impacts on the agriculture industry, as the absence of domestically available jute bags for the export of agricultural products hampers the export of cocoa and other produce, according to a recent statement by Sabo Nanono, the Minister of Agriculture and Rural Development. According to the minister, plans are under way to set up jute bag factories across the country and to promote the cultivation of kenaf (Izuaka, 2021).

Given political will and the availability of required technology, a domestic jute industry could be set up if public and private investors invest in kenaf production (Ibirogba, 2020). However, the focus is on large bags to be used for the export of agricultural commodities, not for the replacement of SUP shopping bags.

c. Price competitiveness of end-use products

As there is no local jute industry, no local jute bags could be identified. The only jute bags available on the online shopping site Jumia were listed as a product shipped from abroad for ₦72,093 ($190), making them a luxury item and unfit to replace SUP shopping bags.

d. Conclusion

Currently, the jute industry is not suited to be scaled up to replace SUP products owing to the lack of access to raw materials and the lack of manufacturing capability. Recent programmes launched by the Nigerian Government to promote a kenaf-based bio-economy could significantly improve the availability of jute-based products in the future, though, so jute bags could become a viable option.

5.3.4. Cotton

a. Domestic availability of feedstock to manufacturers

Cotton bags were identified as another potential option to replace SUP grocery bags in Nigeria. Unlike the paper and jute industries, the cotton industry in Nigeria is still present, though not as productive as in the early 1960s when Nigeria was Africa's biggest cotton producer. Over the last several decades, however, textile milling across the country has collapsed. The majority of ginneries are thus obsolete, and human capacity in the industry is extremely low. According to a factsheet produced by the Nigerian Federal Ministry of Industry Trade and Investment (2017), in 2017 only 17 of 52 ginneries were operational.

According to Anibe Achimugu, president of the National Cotton Association of Nigeria, the major problem that the industry faces is access to the good-quality inputs required to achieve maximum yields, such as improved seeds and seedlings, despite the efforts of the Nigerian Government to address the issue (Faminu, 2021). Still, data from United States Department of Agriculture (2021) show that despite a drop in local production, Nigeria remains a net exporter of cotton.

b. Availability of manufacturing capacity

With the decline in domestic cotton production, the textile industry suffered equally. It does not contribute to foreign exchange earnings or employment generation any more as most factories have shut down. According to Owen et al. (2016), the decline was mostly caused by inadequate power supply, inconsistent government policies, rampant smuggling of foreign textiles and market insecurity. As a result, in 2018 Nigeria was importing nearly $550 million in clothing and textiles, according to statistics from the World Bank (2021). As a way to address the issue and boost local production, the Central Bank of Nigeria added textiles to its list of items that are not eligible for foreign exchange in 2019, making their import significantly more difficult.

c. Price competitiveness of end-use products

Cotton-based tote bags are available in Nigeria from about ₦2,000 ($4.86) on online platforms such as Jumia (2021) and Konga (2021). As such, they are significantly more expensive than SUP offerings and are considered a fashion object rather than an object to be used for regular shopping activities.

d. Conclusion

Cotton is available in the market and is locally produced yet is not widely used as a SUP shopping bag alternative, mainly because of its relatively high price. However, if customers change their behaviour and switch from a single-use model to a reuse model, cotton bags could become an economically viable alternative – albeit one requiring initial investment.

5.3.5. Plantain and banana leaves

a. Domestic availability of feedstock to manufacturers

Plantain and banana leaves have been used for decades in Nigeria to prepare and serve traditional dishes. Especially in rural areas, modern packaging materials such as plastics have not been able to replace these leaves, which are mainly used in the informal food sector. According to Ezeudu et al. (2020), the leaves are widely available throughout Nigeria, even in urban areas where they are now being sold on some markets.

b. Availability of manufacturing capacity

Using leaves to serve dishes entails no manufacturing process other than washing the leaves to ensure basic hygienic conditions.

c. Price competitiveness of end-use products

As noted, leaves are available throughout the country; they are free in rural areas or sold for just a few naira in urban markets, making them an economically preferable option over SUP plates or takeaway containers (Ezeudu et al., 2020).

d. Conclusion

Banana and plantain leaves offer a great way to serve food. They are already widely used for traditional foods, and their use could be extended for more offerings. However, hygienic aspects would need to be studied further, and their applicability might be limited in urban areas and in formal food-serving industries.

5.3.6. Wheat stems

a. Domestic availability of feedstock to manufacturers

Wheat stems have been identified as a potential feedstock for producing straws. However, according to data from the United States Department of Agriculture (2020), over the last years Nigeria has produced only 60,000 tonnes of wheat and has imported more than 5 Mt per year. Less than 1.5 per cent of domestic demand is met by local production.

b. Availability of manufacturing capacity

Straws made from wheat stems do not require any manufacturing capacity.

c. Price competitiveness of end-use products

No straws made from wheat stems were identified in the market research; thus no prices could be assessed.

d. Conclusion

The lack of local wheat production and the reliance on imports make wheat stems unlikely to be available in large quantities for straw production; thus, they are not a viable alternative for SUP straws in Nigeria.

5.3.7. Glass

a. Domestic availability of feedstock to manufacturers

Glass bottles represent one option for replacing PET bottles, which are widely used in Nigeria. The base material for glass is quartz and silica sand, of which Nigeria has extensive deposits. A market research study by Foraminifera Market Research Limited (2021) found that base material comes mostly from sedimentary areas on the southern coastal plain, although deposits also occur in some inland areas.

b. Availability of manufacturing capacity

Nigeria has various glass manufacturers, with Beta Glass Plc being one of the biggest. The company was established in 1974 and has the largest glass container production capacity in West Africa, according to its 2019 annual report (Beta Glass Plc, 2019). It has two plants and three furnaces in Nigeria; total production capacity is more than 600 tonnes/day of glass containers, and the company plans to increase that to 700 tonnes/day. According to an article by Benson (2018a), the company's main competitors are companies that specialize in manufacturing PET bottles. Still, the company's annual report showed that revenue doubled between 2015 and 2019, indicating a highly profitable business.

c. Price competitiveness of end-use products

Prices of PET bottles and glass bottles are difficult to compare given that the price is usually attributed to the overall product, which is the filled bottle, not the bottle alone. Manufacturing prices for glass bottles could not be established; however, a study by Osifuwa (2020) suggested that the use of glass beverage bottles is cost-effective, mostly due to a take-back scheme in the country that results in a larger profit margin for glass-bottled beverages than for PET-bottled ones.

d. Take-back schemes

Glass bottles in Nigeria are sold by major manufacturers under a returnable scheme that has been in place for decades. The bottles are seen as company assets that need to be returned to be refilled. Throughout the value chain, a value is set for glass bottles (and the crates they travel in). That value is refunded only after the buyer returns the empty glass bottles and crates to the brewery or bottling plant (Osifuwa, 2020).

e. Conclusion

Glass offers an economically viable alternative to the use of PET bottles and is likely to be scaled up. Further investment in glass bottle production should be supported, given that glass bottles are accepted in the market and the take-back scheme offers benefits from an economic and an environmental perspective.

5.3.8. Aluminium

a. Domestic availability of feedstock to manufacturers

Bauxite, the raw material needed for aluminium production, is available in some parts of Nigeria. Yet the Nigerian Ministry of Mines and Steel Development (2021) currently lists no active operators that mine or explore bauxite reserves in the country. Previously, some mining activities were carried out for the country's sole aluminium smelter. The Aluminium Smelter Company of Nigeria, popularly called ALSCON, was set up in 1997 by the Nigerian Government in Ikot-Abasi, Akwa Ibom State. At optimal capacity, the plant was intended to generate 193,000 tonnes of aluminium annually. It was also designed to utilize and enhance the country's huge gas reserves through a gas-to-power model that would help to reduce gas flaring. However, the plant barely achieved optimal production after its launch and produced only 40,000 tonnes before production was suspended in 1999. A mismanaged privatization process in 2004 has left the Bureau of Public Enterprises entangled in a legal battle between RUSAL of the Russian Federation and the Bancorp Financial Investment Group over ownership of the plant (Eguzozie, 2020).

b. Availability of manufacturing capacity

Because of the lack of domestically produced aluminium, the aluminium industry relies heavily on imports. Nevertheless, various companies in Nigeria make aluminium products, including large players such as First Aluminium Nigeria Plc and Tower Aluminium Plc. The first can manufacturing facility in Nigeria was set up by GZ Industries Limited in 2010 in Agbara, Ogun State (Ehigiator, 2010). In 2012, Alucan Packaging Limited set up a new plant with the capacity to make 1 billion aluminium cans a year, and the option to double the capacity as needed. The company was bought in 2013 by Nampak, a South African packing company operating in various markets in Africa (Eagle, 2013).

c. Price competitiveness of end-use products

Prices of PET bottles and aluminium cans are difficult to compare given that aluminium cans are predominantly used for soft drinks rather than water. Manufacturing prices for aluminium cans could not be established; however, the entrance into the market of major international operators such as Nampak suggests that making and selling aluminium cans in Nigeria is a profitable business.

d. Take-back schemes

There is no formal take-back scheme for aluminium cans in Nigeria. Nonetheless, according to aluminium can producer GZ Industries Limited, aluminium cans are the most often recycled beverage package in Nigeria with an estimated recycling rate of up to 65 per cent. GZ Industries launched its own recycling programme in 2015 and has since collected more than 250 tonnes of aluminium beverage cans (GZ Industries Limited, 2021). Today, Nigeria is home to at least four major aluminium recycling plants, according to an overview of metal recycling plants in Africa by ENF Recycling (2021). Aluminium is collected mostly by stakeholders in the informal waste management sector and then sold in bulk to waste traders, who then sell it further to the recycling plants. According to an investigation by Benson (2018b), 1 tonnes of aluminium cost more than ₦100,000 ($243) in 2018 – making it one of the most valuable resources to recycle, given the lack of domestically available virgin material.

e. Conclusion

Despite the lack of domestically available aluminium, the beverage can industry seems to be operating well and has capacity greater than current needs of the domestic market. As such, aluminium cans represent a viable option to replace PET bottles.

5.4. Conclusions and recommendations

Drawing on the assessment carried out in the case countries, Table 5.7 ranks the materials under study on their techno-economic performance. For each country and category, alternative materials are identified that could be scaled up to replace SUP products in the respective markets for the product categories under study.

It is critical to take into consideration the sustainability impacts associated with these alternatives, as highlighted in Chapter 4, in order to avoid having replacement of plastic products result in unintended sustainability challenges. In addition, for some products like sachet water, no viable alternative was identified; thus, rather than a change of material, a change of consumer behaviour or a systems change would be needed.

Table 5.7. Options to replace SUP products, from a techno-economic perspective

Country	Takeaway containers	Grocery bags	Plates	Straws	Bottles	Sachets
Bangladesh	Areca leaves Banana leaves Paper	Cotton (jhoot) Jute Banana pseudo-stem and fibre Paper	Areca leaves Banana leaves	Paper Bamboo	Glass Aluminium	No viable option available
Kenya	Paper	Paper Sisal	Coconut husks	Wheat stem	Glass Aluminium	No viable option available
Nigeria	Banana leaves Paper	Cotton Jute Paper	Banana leaves	No viable option available	Glass Aluminium	No viable option available

CHAPTER 6. TRADE FLOW TRENDS IN PLASTICS AND NON-PLASTIC SUBSTITUTES AND BARRIERS TO TRADE FOR SUB-SAHARAN AFRICA AND SOUTH ASIA

This chapter provides an overview of the main findings on trade-flow trends and trade barriers (tariff and non-tariff measures) for key plastic and non-plastic substitutes, including both feedstocks and end-use products. The focus is on the three case-study countries: Bangladesh, Kenya and Nigeria. Annex II provides an overview of the methodology used in analysing trade flows and assessing revealed comparative advantage for selected plastic and non-plastic feedstock materials as well as end-use products.

6.1. Trade flows analysis: summary of the main findings

This section summarizes some main findings from the trade-flow data for the feedstock and end-use product subheadings in Annex Tables A3.2–5. Some are illustrated in Figures 6.1a, b, c and d and 6.2a, b and c.

6.1.1. SMEP countries

a. Overall profile of top exporters

All SMEP countries appear to be net importers of plastic feedstocks. However, for certain SMEP countries the trade balance becomes more favourable in non-plastic feedstocks, including natural fibres (Kenya, Nigeria, Senegal, Uganda and Zambia), agricultural by-products (Bangladesh, Ghana and Kenya) and minerals (Ghana, Nigeria, Rwanda and Zambia). Data are missing or not reported for some SMEP countries for their latest reporting years (2015, 2017, 2018 and 2019).

b. Notable trends in feedstocks

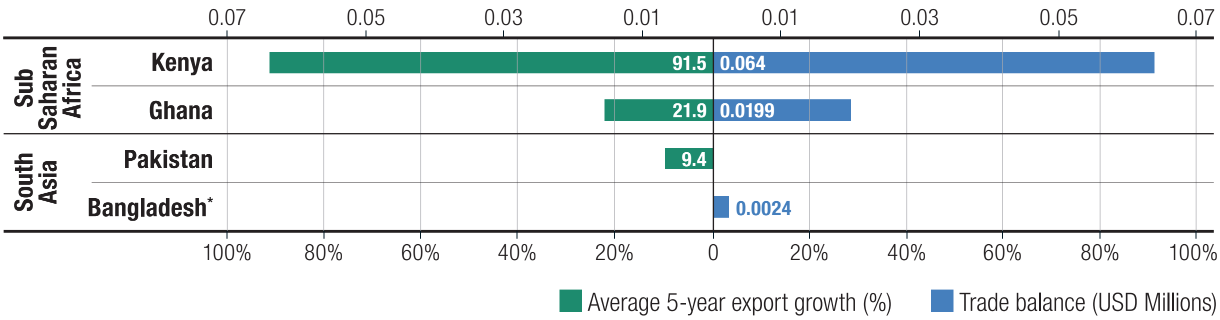
Double-digit growth rates were recorded in exports of plastic feedstocks between 2015 and 2019 by Nigeria (31.6 per cent), Zambia (30.9 per cent), Senegal (28.8 per cent) and Kenya (10.9 per cent). Although export growth rates for natural fibres and minerals over the same period were generally negative, strong positive trends can be seen for agricultural by-products in Kenya (91.5 per cent), Ghana (21.9 per cent) and Pakistan (9.4 per cent). Available data show positive growth trends in the minerals category, which comprises glass and aluminium feedstocks, mainly for Pakistan (67.6 per cent) and Rwanda (0.6 per cent).

c. Notable trends in end-use products

For plastic end-use products, most SMEP countries appear to be large net importers. Notable exceptions – large net exporters – include Bangladesh for grocery bags, Ghana for grocery bags and food containers, Kenya for food and liquid containers and the United Republic of Tanzania for food containers. However, in certain categories of non-plastic end-use products, some of the net export figures are much larger and spread over more SMEP countries than those for plastic bags. This indicates promising potential for SMEP countries to supply non-plastic substitutes for SUP bags. In other categories of non-plastic end-use

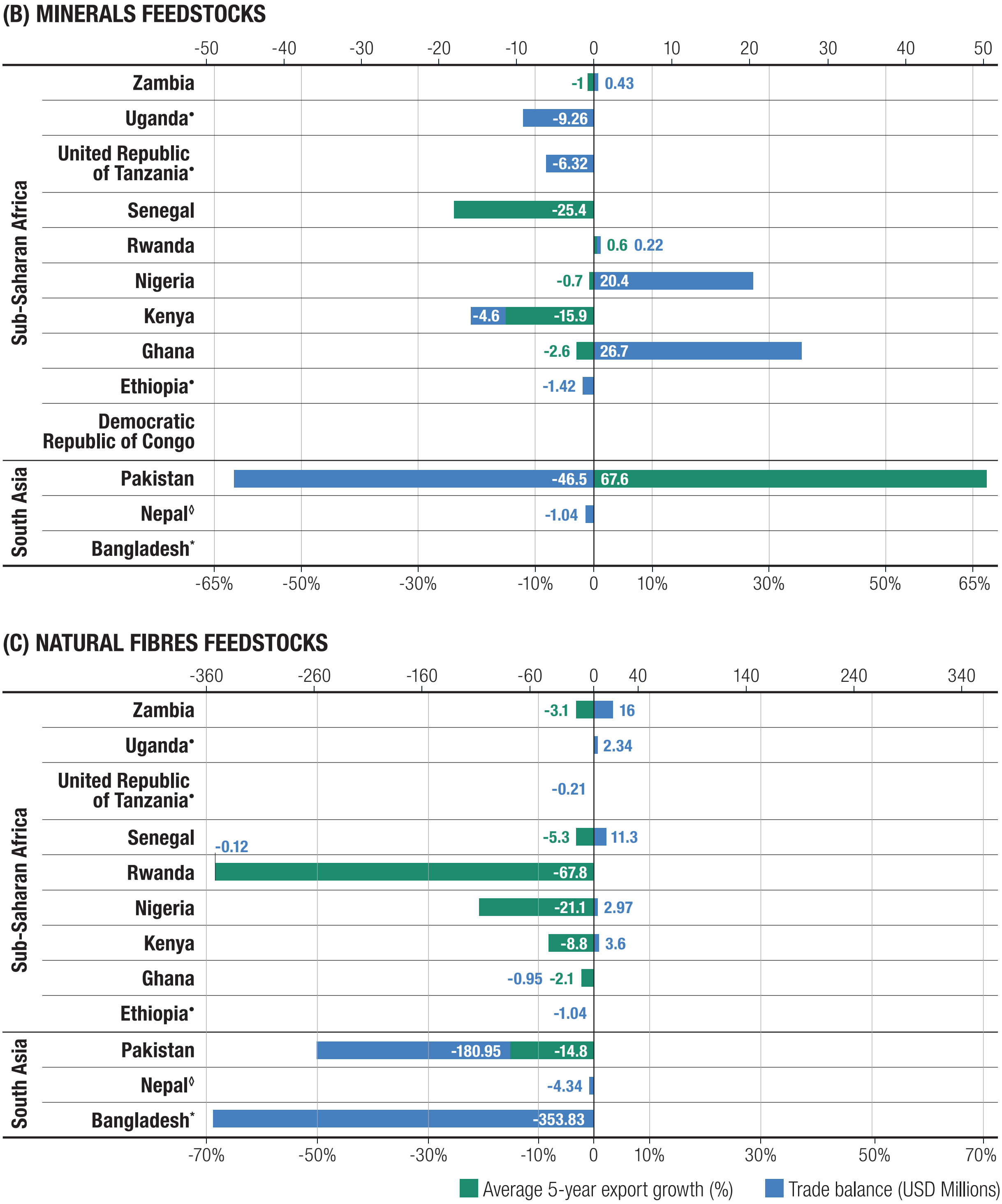
Figure 6.1. Plastic and non-plastic feedstocks: Trade flow trends for SMEP countries
Trade balance and five-year average growth rate, 2015–2019 (Millions of dollars and per cent)

(A) AGRICULTURE BY-PRODUCT FEEDSTOCKS



Note: All data are for 2019 unless specified. *Data for 2015 products, SMEP countries are largely net importers. Greater expansion of manufacturing capacity using locally available feedstock could perhaps help alleviate dependence on imports of non-plastic end-use products. This could also reduce imports of many plastic end-use products as well.

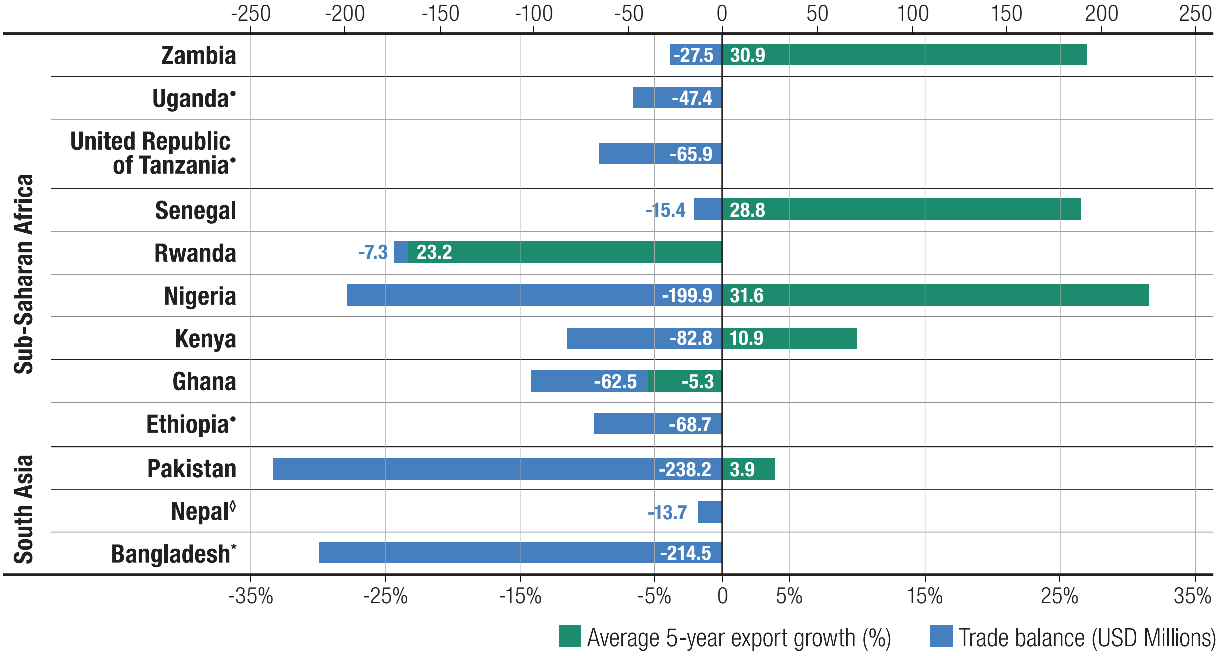
Figure 6.1. Plastic and non-plastic feedstocks: Trade flow trends for SMEP countries (cont.)
Trade balance and five-year average growth rate, 2015–2019 (Millions of dollars and per cent)



Note: All data are for 2019 unless specified. *Data for 2015 ◊ Data for 2017 • Data for 2018

Figure 6.1. Plastic and non-plastic feedstocks: Trade flow trends for SMEP countries (cont.)
Trade balance and five-year average growth rate, 2015–2019 (Millions of dollars and per cent)

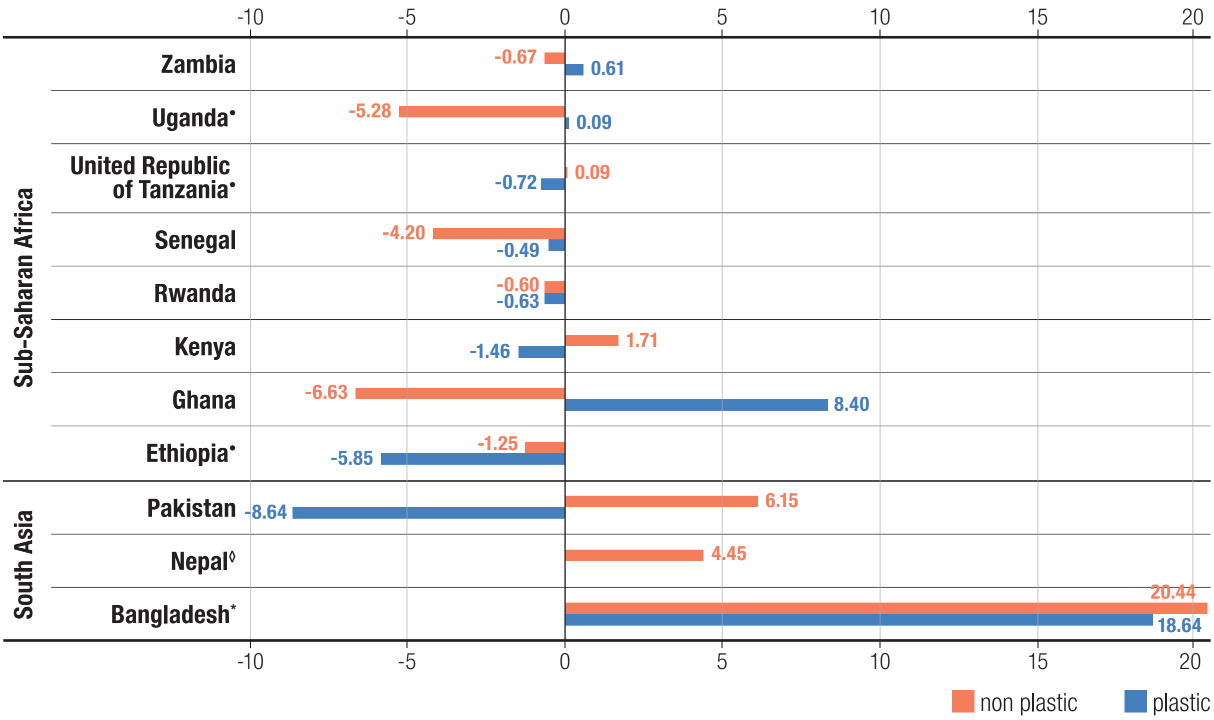
(D) PLASTIC FEEDSTOCKS



Note: All data are for 2019 unless specified. *Data for 2015 ◊ Data for 2017 • Data for 2018
Source: Based on UN Comtrade analysis (UN, 2021).

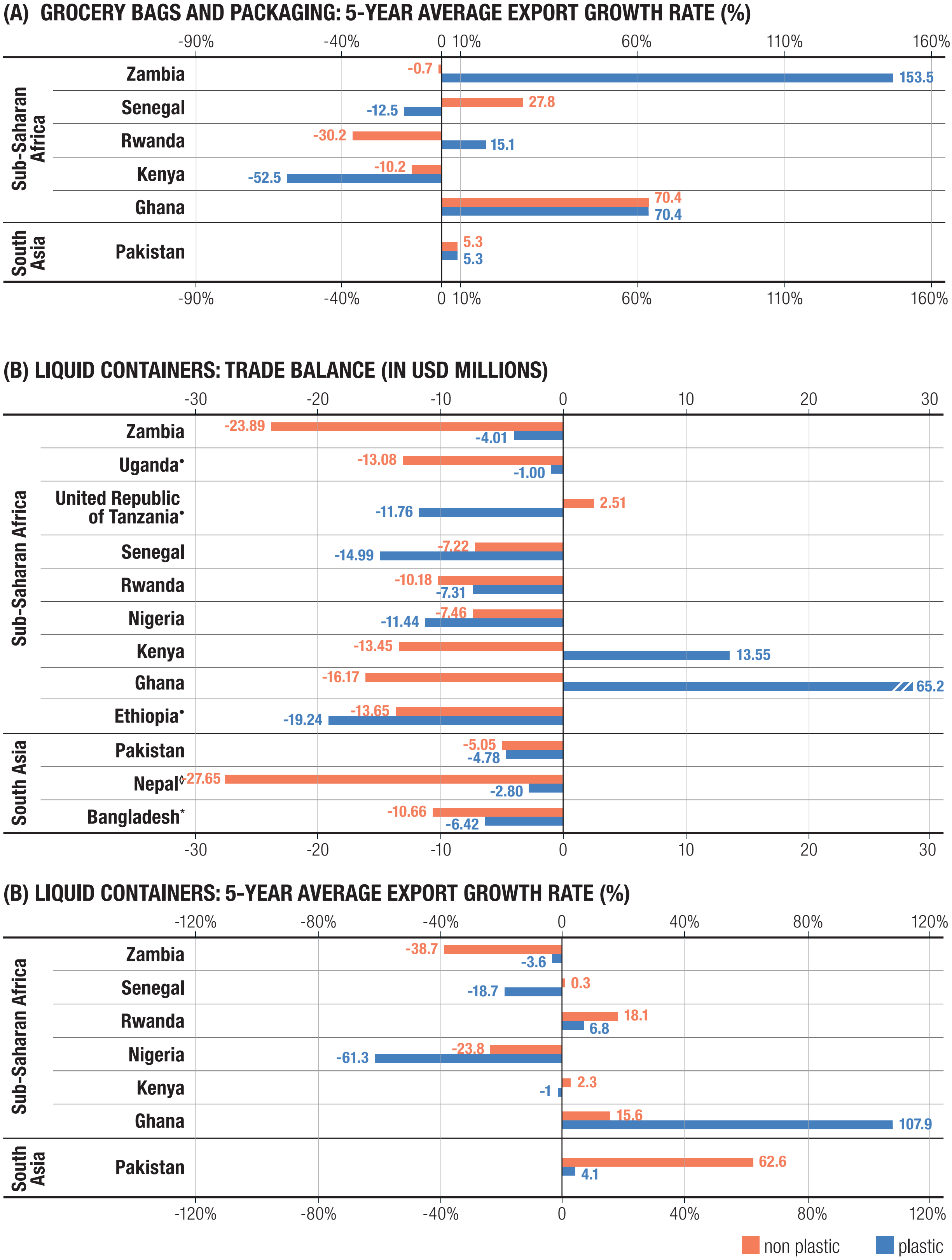
Figure 6.2. Plastic and non-plastic end-use products: Trade flow trends for SMEP countries
Trade balance and five-year average growth rate, 2015–2019 (Millions of dollars and per cent)

(A) GROCERY BAGS AND PACKAGING: TRADE BALANCE (IN USD MILLIONS)



Note: All data are for 2019 unless specified. *Data for 2015 ◊ Data for 2017 • Data for 2018

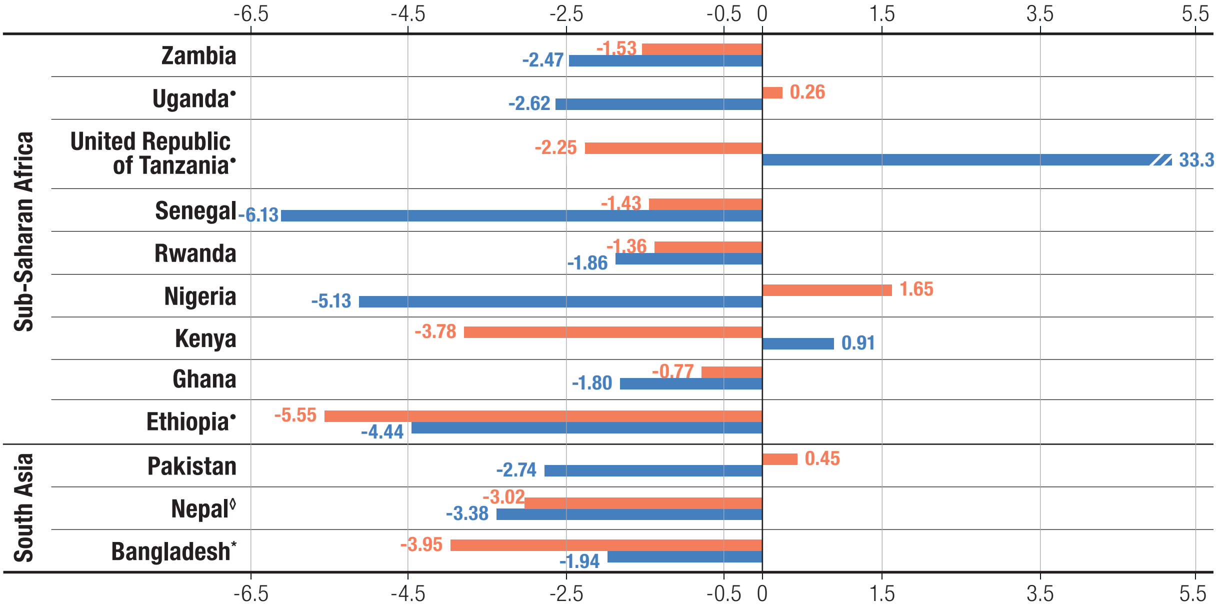
Figure 6.2. Plastic and non-plastic end-use products: Trade flow trends for SMEP countries (cont.)
Trade balance and five-year average growth rate, 2015–2019 (Millions of dollars and per cent)



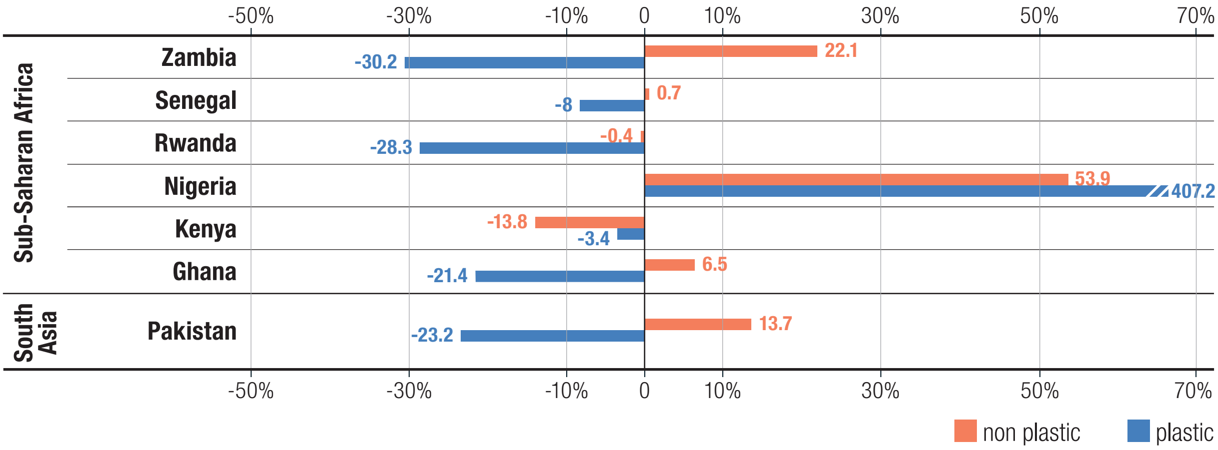
Note: All data are for 2019 unless specified. *Data for 2015 ◊ Data for 2017 • Data for 2018

Figure 6.2. Plastic and non-plastic end-use products: Trade flow trends for SMEP countries (cont.)
Trade balance and five-year average growth rate, 2015–2019 (Millions of dollars and per cent)

(C) FOOD CONTAINERS AND SINGLE-USE ACCESSORIES: TRADE BALANCE (IN USD MILLIONS)



(C) FOOD CONTAINERS AND SINGLE-USE ACCESSORIES: 5-YEAR AVERAGE EXPORT GROWTH RATE (%)



Note: All data are for 2019 unless specified. *Data for 2015 ◊ Data for 2017 • Data for 2018
Source: Based on UN Comtrade analysis (UN, 2021).

d. Analysis of RCA trends for 2019 (Annex Table A3.2)

SMEP countries across the two regions display an RCA in exports of non-plastic feedstocks, particularly in natural fibres. In South Asia, both Bangladesh and Nepal display competitiveness, while in sub-Saharan Africa, most SMEP countries seem to be competitive, with the exceptions of Ghana, Nigeria and Rwanda. Pakistan is the only SMEP country in South Asia with an RCA in exports of agricultural by-product feedstocks. Data for sub-Saharan Africa for this subcategory are widely unreported for the year 2019. For exports of mineral-based feedstocks, Pakistan and Ghana are the only two SMEP countries in the analysis with an RCA index greater than 1. (For an explanation of the RCA index, please see the methodology section in Annex II).

For end-use products, most countries in the analysis do not exhibit an RCA in exports of plastic products. However, a few exceptions exist: Bangladesh in exports of plastic grocery bags or packaging; the United Republic of Tanzania in exports of plastic food containers and single-use accessories; and Nepal, as well as Ghana, Kenya, Senegal and Uganda, in exports of plastic liquid containers. Most countries in South Asia and sub-Saharan Africa seem to have an RCA in exports of non-plastic grocery bags and packaging, with the exceptions of Ethiopia and Rwanda.

6.1.2. Top five global and regional exporters and importers (Annex Table A3.3)

a. Overall profile of top exporters

Most of the top five exporters of plastic feedstocks are OECD countries, with the exception of Saudi Arabia. For non-plastic feedstocks, a few mostly larger developing countries such as Brazil and India are leading exporters. Pakistan is the only SMEP country among exporters of agricultural by-products, the fifth largest.

b. Notable trends in feedstocks

SMEP countries such as Pakistan in South Asia and South Africa, Nigeria and Kenya in sub-Saharan Africa have emerged as the leading exporters of plastic feedstocks in terms of value in their respective regions. Yet the overall export values in non-plastic categories, particularly natural fibres and minerals, are much larger in value than in plastic feedstocks, especially in Zambia (for natural fibres) and South Africa, Ghana and Nigeria (for minerals such as glass and glass scrap, and unwrought aluminium and aluminium scrap). Overall export growth rates in plastic feedstocks are positive and higher for the top South Asian and sub-Saharan exporters than for the individual non-plastic feedstocks. Nevertheless, although the highest growth rate over 2015–2019 for plastic feedstocks in South Asia and sub-Saharan Africa was 0.29 per cent for Senegal, in many non-plastic feedstocks the rates were much higher. This can be seen for example for agricultural by-products in Kenya (0.91 per cent) and Benin (0.45 per cent) and for minerals in Pakistan (0.68 per cent). A similar trend can be seen for feedstock imports among the top five importers in South Asia and sub-Saharan Africa. The highest rate of import growth in plastic feedstocks over 2015–2019 was 0.12 per cent for Ghana. However, import growth rates during the same period for agricultural by-products were 0.68 per cent for India and 0.87 per cent for Cabo Verde. Similarly, for minerals (glass and aluminium), it was 0.82 per cent in Ghana and 0.39 per cent in Madagascar.

c. Notable trends in end-use products

The top exporters as well as importers in South Asia include India and Pakistan in all product categories – both plastic and non-plastic. The top five exporters in sub-Saharan Africa include South Africa, Kenya and Ghana in most cases, whereas Nigeria appears among the top exporters only for non-plastic containers for liquids. Among importers, Pakistan appears as the leader for plastic grocery bags whereas India is the leader in all other categories. In sub-Saharan Africa, South Africa is the top importer in nearly all categories. Nigeria appears among the top five importers for plastic end-use products: fifth largest for plastic food containers and single-use accessories, and grocery bags, and fourth largest for plastic bottles for liquids.

A comparison of plastic and non-plastic end-use product categories reveals some interesting findings. In South Asia, the export figures for various non-plastic categories seem to be much larger than for plastics. In sub-Saharan Africa, export values overall are much higher for non-plastic substitutes only in the categories of food containers and single-use accessories. In other categories export values for plastic end-use products are much higher. Export growth rates over 2015–2019 vary country by country, and no clear trend can be discerned for all countries by product category. However, export growth rates above 1 per cent are seen only in liquid plastic containers for Ghana (1.08 per cent) and Mauritius (1.50 per cent). This may be an indicator of the ease with which plastic product manufacturing facilities can be set up, helped by low plastic feedstock prices. The cheaper prices of plastic end-use products in general encourage domestic and export markets for plastic products, including at a regional level. Import values overall seem to be much higher in non-plastic end-use products than in plastic end-use products. Aberrations exist for specific countries and products. Once again, no discernible differences in growth rates between plastic and non-plastic categories can be identified for top importers in South Asia and sub-Saharan Africa.

6.1.3. Regional trends

This subsection addresses aggregate export and import values and growth rates for South Asia and sub-Saharan Africa (Annex Table A3.4).

a. Notable trends in feedstocks

For both regions, aggregate export and import values for non-plastic feedstocks are much larger than export values for plastic feedstocks. South Asia is a net importer of plastic feedstocks and natural fibres and a net exporter in all other categories. Over 2015–19 higher export growth rates were seen in non-plastic feedstocks sectors such as minerals (0.33 per cent) and agricultural by-products (0.08 per cent) than in plastic feedstocks (0.06 per cent). Import growth rates in that period were much higher in agricultural by-products (0.68 per cent) than in plastic feedstocks (0.02 per cent). Sub-Saharan Africa is a net exporter of natural fibres and minerals and a net importer in all other categories, including plastic feedstocks. Over 2015–2019 only agricultural by-products (0.41 per cent) exceeded plastic feedstocks (0.19 per cent) in export growth rates. Import growth rates then were higher in natural fibres (0.06 per cent), agricultural by-products (0.10 per cent) and minerals (0.17 per cent) than in plastic feedstocks (0.04 per cent).

b. Notable trends in end-use products

In South Asia, both export and import values are much higher in all three non-plastic categories than for their plastic counterparts, namely food containers and single-use accessories, grocery bags and packaging and liquid containers. In sub-Saharan Africa, export values are also higher for non-plastic categories except for liquid containers. Import values are higher in all non-plastic categories than for their plastic counterparts. Comparing exports and imports as a whole within categories, South Asia is a net exporter in all plastic as well as non-plastic categories. Sub-Saharan Africa is a net exporter in plastic grocery bags and packaging and in plastic liquid containers but a net importer in all other categories. For South Asia, the export growth rate over 2015–2019 is highest for non-plastic liquid containers (0.33 per cent), while the import growth rate is highest for plastic liquid containers (0.13 per cent). For sub-Saharan Africa, the export growth rate over the same period is highest for non-plastic grocery bags and packaging (0.27 per cent), whereas the import growth rate is highest for non-plastic grocery bags and packaging (0.08 per cent).

6.1.4. Country-specific trends

This subsection addresses key trade trends and RCA scores for Bangladesh, Kenya and Nigeria (Annex Table A3.5 and Figures 6.3, 6.4 and 6.5) based on the latest reporting year.[8]

a. Bangladesh

Data are not available for estimating export and import growth rates over 2015–2019. Export and import values presented are on the basis of data reported for 2015.

i. Plastic feedstocks

For most of the listed subheadings, except plastic waste and scrap, Bangladesh is a net importer. The top export markets lie in Asia, including India and Sri Lanka (in South Asia), the Republic of Korea, Myanmar and Thailand. In the Middle East, the United Arab Emirates is a top market. Among developed countries, Canada is a top market for polystyrene exports and the United Kingdom for polyacetal exports (including PET). In South Asia, India is a top export market for polyethylene, polypropylene and polyacetals (including PET), as well as plastic waste and scrap. Sri Lanka is a top export market for polypropylene. The top import sources mostly include oil-producing countries in the Gulf such as Oman, Qatar, Saudi Arabia and the United Arab Emirates, and larger developing countries such as China, India, the Republic of Korea, Malaysia, Singapore and Thailand. Developed-country import sources include Germany for plastic waste and scrap. In South Asia, India is a top import source for polystyrene and polyacetals (including PET).

ii. Non-plastic feedstocks

Bangladesh is a net exporter of jute and sisal and has a smaller positive net export value in cereal straw and husks. Its top export markets include both developed and developing countries: Canada, the European Union (especially the Netherlands), Japan, Switzerland and the United Kingdom, as well as China, India, the Republic of Korea, Pakistan, Saudi Arabia, Sri Lanka and the United Arab Emirates. The Russian Federation is also a top export market for sisal. Interestingly, Côte d'Ivoire in sub-Saharan Africa is a top destination for exports of jute from Bangladesh. This is likely due to widespread use of jute in developing countries for packaging of products, particularly those such as cocoa or coffee beans (Reuters, 2017). Within South Asia, India is a top market for jute and sisal and Pakistan for jute, aluminium waste and scrap as well as vegetable materials for plaiting (such as banana and areca leaves). Sri Lanka is a top export market for paper and cardboard and for vegetable materials for plaiting. Top import sources mostly include larger Asian countries such as China, India and Indonesia but also a few developed countries such as Australia; Germany, Italy and Spain; and Japan. Within South Asia, India is a top import source for paper and cardboard, cotton, coconut and other fibres, sisal, glass cullet and scrap, and vegetable plaiting materials. Sri Lanka is a top import source for coconut fibre, unwrought aluminium, glass cullet and scrap.

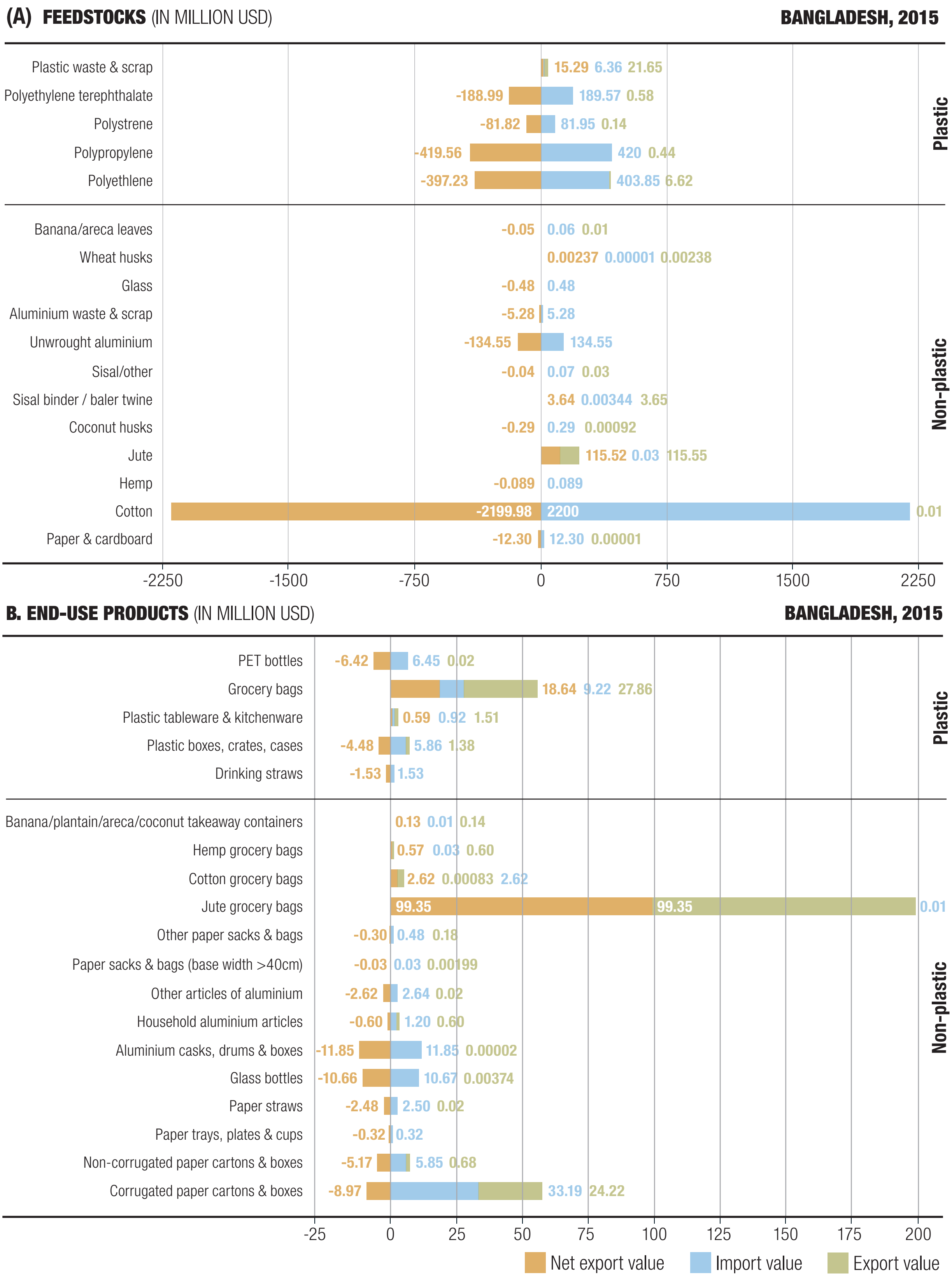
iii. Plastic end-use products

Bangladesh is a net exporter of plastic tableware and kitchenware and plastic bags and a net importer of plastic tubes and pipes (including straws), plastic boxes and cases and plastic bottles. Top export markets include both developed countries, including a number of European Union countries, the United Kingdom, the United States and Japan, and developing countries such as China, India and Saudi Arabia. Within South Asia, Bhutan and India are top markets for exports of plastic bags from Bangladesh while Sri Lanka is a top market for exports of plastic boxes and cases. Top import sources for Bangladesh include mostly larger Asian developing countries, particularly China, India and Indonesia, and also Germany and Italy, and the United Kingdom. Within South Asia, Sri Lanka is a top import source for plastic tubes and pipes (including drinking straws) and India is a top import source for plastic boxes and cases and plastic bags.

iv. Non-plastic end-use products

For non-plastic end-use products, Bangladesh is a net importer in most cases, except for containers made of vegetable plaiting materials, jute bags, cotton bags and bags of other textile materials (such as hemp). The top export markets include many developed countries: Australia, Canada, many from the European Union (Belgium, Denmark, Germany, Greece, Italy, Netherlands, Romania and Spain), Japan, Switzerland, the United Kingdom and the United States. They also include developing countries such as the India, Indonesia, Jordan, the Republic of Korea, Mauritius, Myanmar, Turkey, the United Arab Emirates and Singapore. Within South Asia, India is a top export market for aluminium bottles and jute bags. The top import sources for Bangladesh are mainly Asian developing countries such as China, India, Malaysia, Singapore, Thailand and Viet Nam. Saudi Arabia and the United Arab Emirates also are top import sources for aluminium bottles. Top import sources for developed countries include European Union countries (Germany, Italy and Denmark), the United Kingdom and the United States. Within South Asia, India is a top import source for articles and containers of vegetable plaiting materials, boxes and cases of non-corrugated paper and paperboard, glass bottles, kitchen and household articles of aluminium, other aluminium articles, paper bags and sacks as well as jute bags. India and Bangladesh – both big producers of jute – export and import jute bags from each other. There is also two-way trade in aluminium articles.

Figure 6.3. Bangladesh: Exports, imports and net export values for plastic and non-plastic feedstocks and end-use products



Source: Based on UN Comtrade analysis (UN, 2021).

b. Kenya

i. Plastic feedstocks

For all listed plastic feedstocks, Kenya is a net importer. It enjoyed slightly positive export growth rates in 2015–19 in polyethylene, polypropylene and PS. The top export markets for the various feedstocks include many developing countries particularly in Africa (the Democratic Republic of the Congo, Malawi, Rwanda, the United Republic of Tanzania and Uganda, as well as Lesotho and South Africa). In East Africa, this trade is helped by the East African Community (EAC). Top export markets outside Africa include Canada, China, Ireland, India, Ukraine and Viet Nam. The top five import sources mostly lie outside Africa except for South Africa (for polypropylene) and Egypt (for polyethylene and polyacetals such as PET). Major import sources outside Africa include oil exporters (the European Union, Japan, Qatar, Saudi Arabia, the United Arab Emirates and the United States), and large developing countries (China, India and the Republic of Korea).

ii. Non-plastic feedstocks

Kenya is a net exporter of most non-plastic feedstocks (jute, coconut husks, sisal and aluminium waste and scrap), with smaller net export values in cereal straw and husks, vegetable plaiting materials (e.g. banana and areca leaves) and glass cullet and scrap. Export growth rates over 2015–19 were positive and relatively higher for sisal (0.41 per cent) and cereal straw and husks (0.91 per cent). The top export markets lie mainly in developing countries, particularly in Africa. The top five in paper and cardboard lie entirely in Africa: Burundi, Rwanda, the United Republic of Tanzania, Uganda and Zambia. Other developing-country markets include China, India, the Republic of Korea, Saudi Arabia and Thailand. Denmark is the only developed country among the top five export markets for cereal straw and husks. The top import sources, mostly outside Africa, include developed countries (Belgium, Germany, Spain) and developing countries (China, India, Viet Nam). Top sources in Africa are Uganda and the United Republic of Tanzania (cotton).

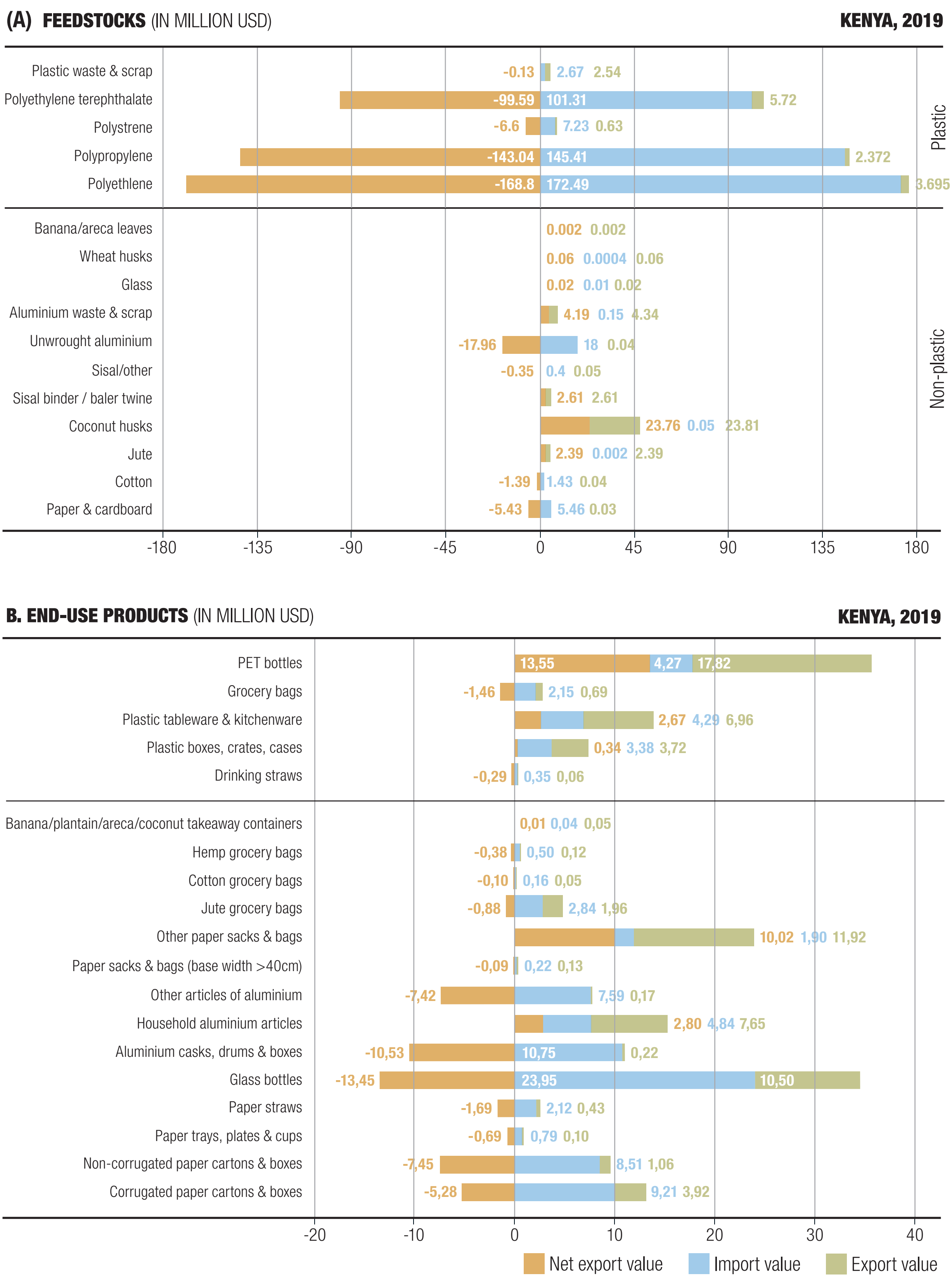
iii. Plastic end-use products

Kenya is a net importer for certain subheadings such as plastic tubes and pipes (including drinking straws) and plastic grocery bags, and a net exporter of plastic boxes and cases, tableware and bottles. However, export growth rates over 2015–19 were very low or negative. The top export markets lie in Africa, mainly countries in East Africa and the Democratic Republic of Congo. The top import sources mostly lie outside Africa and comprise larger developing countries such as China, India, the Philippines, Saudi Arabia, Sri Lanka, the United Arab Emirates and Viet Nam, as well as European Union countries (Germany, Italy, the Netherlands and Portugal). Within Africa, Uganda is among the top five import sources for plastic boxes and cases, South Africa for plastic grocery bags and plastic bottles, and Egypt for plastic bottles.

iv. Non-plastic end-use products

Kenya is mostly a net exporter but enjoys relatively large net export values for aluminium table and kitchen articles and paper bags and smaller net export values for baskets and containers made of vegetable plaiting materials. Export growth rates over 2015–2019 were higher for other paper articles such as straws (0.12 per cent) and bags and sacks (0.14 per cent), with smaller positive growth rates for glass bottles (0.02 per cent), aluminium casks and cans (0.03 per cent), baskets and containers of vegetable materials (0.06 per cent), jute bags and sacks (0.05 per cent) and cotton bags and sacks (0.07 per cent). Import growth rates are relatively higher for bags and sacks of cotton (0.71 per cent) and of other textile materials such as hemp (0.29 per cent). The top five export markets mainly lie in East Africa; others include Japan, the United States and Canada for baskets and other articles made of vegetable materials, Japan for paper plates and cups, France for glass bottles, the United States and several European Union countries for cotton bags, and the United Kingdom and the United States for grocery bags of other materials such as hemp. Afghanistan, Kazakhstan and Pakistan feature among top developing-country markets outside Africa. The top five import sources for the various product subheadings include developing countries: China, India, Saudi Arabia, Sri Lanka and the United Arab Emirates and for certain subheadings also the United States, the United Kingdom, France and Spain. In Africa top import sources for the different products include Egypt, Madagascar, South Africa, the Sudan, the United Republic of Tanzania and Uganda.

Figure 6.4. Kenya: Exports, imports and net exports values for plastic and non-plastic feedstocks and end-use products



Source: Based on UN Comtrade analysis (UN, 2021).

c. Nigeria

i. Plastic feedstocks

For all listed subheadings, Nigeria is a net importer, with a slightly positive (1.4 per cent) export growth rate over 2015–19 in polyethylene feedstock. The top five export markets as well as import sources lie mainly outside Africa. They include the United States and the European Union as well as larger developing countries such as Brazil, China, India, the Republic of Korea, Malaysia, Saudi Arabia, Thailand and Viet Nam. Within Africa, major export markets for Nigeria include Morocco (for polyethylene) and Angola (for plastic waste and scrap). Top African import sources include South Africa (for polypropylene).

ii. Non-plastic feedstocks

For many of the listed subheadings, Nigeria again is a net importer. Notable exceptions, for which it is a net exporter, include cotton and unwrought aluminium and, at a smaller net export value, glass (including glass scrap). Data on five-year export growth rates are unavailable although import growth rates show a slight positive trend. The top export markets include developing countries such as India, the Republic of Korea, Malaysia, Pakistan and Viet Nam, as well as developed countries such as Germany and Japan. The top import sources include major developed economies such as the United States, the European Union, the United Kingdom and developing countries such as China, India, the Republic of Korea, the United Arab Emirates and Viet Nam, as well as the Russian Federation. In addition, several African countries appear among the top five import sources for Nigeria in each of the identified non-plastic feedstock subheadings. They include Ethiopia for cotton, Kenya for jute, and Kenya, the United Republic of Tanzania and Mozambique for coconut, abaca and other fibres.

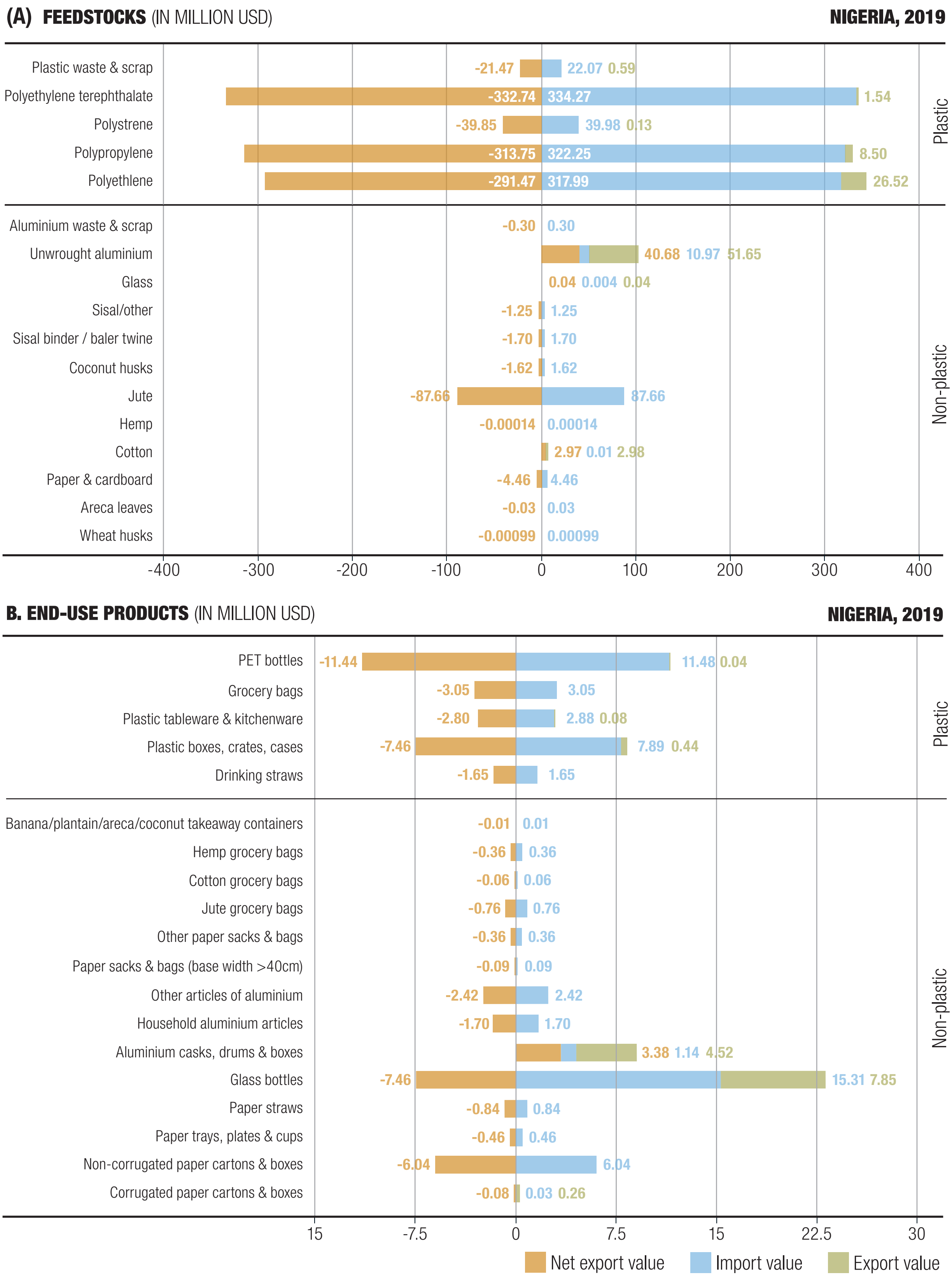
iii. Plastic end-use products

For listed plastic end-use product subheadings, Nigeria overall is a net importer indicating that domestic production was insufficient to meet local demand. Despite being a net importer the export growth rate over 2015–19 was relatively high at 8.46 per cent for plastic tableware and kitchenware. African countries were key export markets. Benin, Niger and Togo appear among the top five export markets for example in plastic boxes (such as food containers). Top import sources for listed subheadings include the United States, European Union countries and Serbia as well as large developing countries such as Brazil, China, India, Indonesia, Malaysia, Myanmar and the United Arab Emirates. Within Africa, South Africa seems to be a major import source for plastic tableware and kitchenware and plastic grocery bags.

iv. Non-plastic end-use products

For listed non-plastic end-use product subheadings, Nigeria is a net importer, except for aluminium casks, cans and containers. Data on five-year export growth rates are missing for several subheadings, but import growth rates seem relatively higher (0.56 per cent) for sacks and bags of other textile materials (such as hemp). On the basis of the limited data available for certain subheadings, the top five export markets outside Africa are the United States, the United Arab Emirates, China and two European Union countries (Italy and Croatia). Several African countries appear among the top five export markets, such as Ghana (for corrugated paper cartons and boxes, and glass bottles) and Togo and Benin (for aluminium casks, cans and containers). The top five import sources for listed subheadings include the United States, European Union countries and Switzerland. Several developing countries, notably China, India and Saudi Arabia, appear among the top import sources. Bangladesh is as a top import source for jute bags. In Africa, top import sources include Egypt (non-corrugated paper cartons and boxes), Ghana (other paper articles such as straws) and South Africa (aluminium kitchen articles and other paper bags and sacks).

Figure 6.5. Nigeria: Exports, imports and net exports values for plastic and non-plastic feedstocks and end-use products



Source: Based on UN Comtrade analysis (UN, 2021).

d. Analysis of RCA trends for Bangladesh, Kenya and Nigeria (based on Annex Table A3.5)

At the four- and six-digit levels of product codes, Nigeria did not exhibit an RCA in exports of feedstocks and end-use products in 2019. The situation in Kenya is more promising, with an RCA in exports of non-plastic feedstocks, especially coconut husks, hemp and sisal. It also has a favourable RCA in exports of plastic liquid containers such as PET bottles, and in grocery bags of paper and jute. Bangladesh stands out among the three case countries, displaying an RCA in exports of product lines in the four categories of feedstocks and products: plastic feedstock (plastic scrap and waste), non-plastic feedstock (natural fibres of jute and sisal), plastic end-use (grocery bags), and non-plastic end-use (paper, jute, hemp and cotton grocery bags).

6.2. Import duties

This section examines import duties for selected headings and subheadings for feedstocks as well as selected end-use products for both SUPs and plastic substitutes. These include the average applied and bound MFN tariffs as well as tariffs applied under regional trade agreements to which Bangladesh, Kenya and Nigeria are parties (Box 6.1 Annex Tables A4.1–6, in the SMEP Trade and Pollution Dashboard under Reports at http://bit.ly/SMEP_UNCTAD).

6.2.1. Bangladesh

Bangladesh imposes an average applied MFN rate of 5 per cent on plastic feedstocks (Annex Table A4.1). Duty rates on non-plastic natural feedstocks range from 5 per cent on cereal straw (e.g. wheat husks), aluminium, glass and coconut fibres to 10 per cent for sisal and vegetable plaiting materials (e.g. areca banana leaves) and 12 per cent for paper and cardboard. Duty rates are higher (25 per cent) for jute, of which Bangladesh is a leading producer, as well as for hemp. Cotton is the only feedstock material imported duty free, and one reason may be its use as a raw material in the country’s textile industry.

Average MFN duties on both plastic and non-plastic end-use products (Annex Table A4.2) are much higher, mostly near 25 per cent. Plastic products with lower average applied duties include drinking straws (13.3 per cent) and PET and other plastic bottles (15 per cent). For non-plastic products, applied tariffs are 7.5 per cent for aluminium casks and cans but rise to 20 and 25 per cent for aluminium kitchen and other

Box 6.1. A guide to tariff terminology

Most-favoured nation versus preferential tariff or duty rates

The WTO states, “Most-favoured Nation tariffs are the ones that WTO members commit to accord to imports from all other WTO members with which they have not signed a preferential agreement. Preferential tariffs are the ones accorded to imports from preferential partners in free trade agreements, customs unions or other preferential trade agreements and are more likely than others to be at zero.”

Bound versus applied tariffs or duties

Import tariffs may be categorized as applied rates or bound rates. Bound rates are ceiling rates as listed in members’ schedules, or lists of commitments above which import tariffs cannot usually be raised. Applied rates are those that members charge, which can be lower than the bound rates. Thus, when governments negotiate tariff reductions in the GATT/WTO, their commitments are of MFN tariff bindings, indicating the upper limit at which they commit to set applied MFN tariffs. For any tariff line, the bound tariff of a WTO member must thus be higher than or equal to the applied MFN tariff, which should be higher than or equal to the preferential tariff, if any.

Sources: WTO (n.d.); UNCTAD (2012).

articles, respectively. For all other non-plastic end-use products, average applied duties are high at 25 per cent. These include paper, cotton and jute bags as well as paper cartons, boxes, plates and cups. Duties of 10 per cent apply to containers made of vegetable plaiting materials, whereas paper articles such as paper straws attract an average duty of 20.7 per cent. Ceiling duty rates (Annex Tables A4.1 and A4.2) are either unbound or very high (at 200 per cent). Only for jute and jute bags are bound rates lower, at 50 per cent.

Bangladesh, as an LDC, benefits from duty- and quota-free access to developed-country markets through preferential schemes such as the European Union's Everything But Arms and the GSP schemes of Canada, Japan and the United States, as well as in key markets such as China and the Republic of Korea. In the region, it benefits from preferential access under the South Asia Free Trade Agreement (SAFTA), especially in India (Rahman, 2014). As of mid-2021, according to the Sri Lanka Department of Commerce (2021), "All countries have completed the respective Trade Liberalization Program…, i.e. brought down tariffs to a level between 0 and 5 per cent on all products other than those in the respective Sensitive Lists". Preferential import duties under SAFTA for non-plastic feedstocks are usually 3–5 per cent, although cotton, unwrought aluminium alloys, cereal straw and husks enjoy duty-free preferential access. The degree of preferential access vis-á-vis MFN duties is particularly high for jute and hemp. It is also greater for manufactured end-use products that are not on the country's sensitive list. These include paper, jute and hemp bags and certain aluminium articles for which preferential duty rates are 5 per cent, versus the average applied MFN rates of 25 per cent.

The revised sensitive list for non-LDCs is illustrative. Annex Table A4.1 shows that all listed plastic feedstock subheadings, except for plastic waste and scrap, appear in the sensitive list even though applied MFN rates are low, at about 5 per cent. Among non-plastic substitute feedstocks, only paper and cardboard are included. As shown in Annex Table A4.2, plastic end-use products are also included. Among non-plastic end-use products, the sensitive list includes paper sacks and bags, cotton bags, corrugated and non-corrugated paper and paperboard boxes and cartons, paper straws, glass bottles and aluminium kitchenware.

6.2.2. Kenya

With regard to MFN duty rates, Annex Table A4.3 shows that listed SUP plastic feedstocks including plastic waste and scrap can be imported into Kenya duty free, except for a 2 per cent average applied MFN duty on polystyrene. Whereas several non-plastic feedstocks such as jute, cotton, hemp, coconut husks, glass and aluminium (including aluminium scrap) can be imported duty free, average applied rates of 10 per cent are levied for feedstocks such as paper and cardboard, vegetable materials (e.g. banana leaves) and wheat husks. For end-use plastic products applied MFN duties are much higher, averaging 25 per cent (Annex Table A4.4). This may be due to protection for the domestic plastic manufacturing industry. The same rate is imposed on non-plastic end-use product subheadings, with a few exceptions such as paper straws (17.5 per cent) and aluminium casks, cans and drums (12.5 per cent). Ceiling rates are unbound in most cases or very high at 100 per cent. Only in the case of polyethylene are bound duties somewhat lower, at 31 per cent.

Kenya benefits from preferential market access through the GSP schemes applied by Australia, Belarus, Canada, the European Union, Japan, Kazakhstan, New Zealand, Norway (under which it is treated as an LDC) as well as the Russian Federation, Switzerland, Turkey and the United States (UNCTAD, 2018).

Kenya is a member of the EAC, which established a common internal market in 2010 and has had a customs union in force since 2005. Trade in goods within the EAC is duty free with a common external tariff, whereby imports from outside the EAC zone are subject to the same tariff when imported by any member country (East African Community, 2021). Not all member countries have ratified the AfCFTA, with those of Burundi, South Sudan and the United Republic of Tanzania still pending at the time of writing. The EAC submitted its tariff offer and schedule of commitments on 3 December 2020 (East African, 2021).

In March 2021, Kenya and the United Kingdom ratified an economic partnership agreement (EPA) that permanently guarantees duty- and quota-free access to the United Kingdom market for Kenyan exports (ensuring continuity of access post-Brexit). It also provides for gradual access for United Kingdom goods to the Kenyan market, with some goods eliminated immediately upon its entry into force, others progressively liberalized to zero duties over a period of 15 years or zero duties over a period of 25 years and some goods excluded from the tariff phase-down regime (British High Commission Nairobi, 2021; United Kingdom Parliament, 2021). The application of this regime to the selected plastic and non-plastic feedstock and end-use products appears in Annex Tables A4.3 and A4.4. The agreement, which is open to other EAC members, is similar to the EU–EAC EPA generally in scope and provisions and specifically in applying the principle of variable geometry[9]. The EU–EAC EPA was signed in October 2014 by Kenya and Rwanda but ratified only by Kenya (European Commission, 2021a; MMan Advocates, 2021).

Annex Table A4.3 shows that plastic feedstock duties proposed under the United Kingdom–Kenya EPA are duty free, as expected given that applied MFN duties are zero. This changes for non-plastic feedstocks. Subheadings related to selected natural materials such as jute, cotton, hemp, coconut fibre and minerals such as glass and aluminium already enjoy MFN duty-free access and continue to do so under the EPA. However, natural fibre subheadings such as paper and cardboard, and sisal, with applied MFN rates of 25 per cent, are excluded from the EPA and thus not subject to tariff cuts. Agricultural by-products such as vegetable materials (e.g. banana and areca leaves) and wheat husks are to be completely liberalized over a period of 15 years after entry into force of the EPA (as of 24 March 2021).

No plastic end-use products in Annex Table A4.4 have been scheduled for tariff phase-down under the EAC Similarly, subheadings related to non-plastic end-use products such as paper, jute and cotton bags, corrugated paper cartons, paper straws, glass bottles and some types of aluminium household articles (including possibly certain types of aluminium bottles) have been excluded. Articles made of vegetable plaiting materials (e.g. plates made of banana leaves, straws made from wheat fibre) and of paper and paperboard are to be liberalized over a 25-year period and folding cartons of non-corrugated paper over a 15-year period. The import duty modalities could reflect sensitive sectors not just in Kenya but in the EAC.

6.2.3. Nigeria

Annex Table A4.5 shows that Nigeria imposes moderately low applied MFN duties, averaging 5 per cent on most subheadings except for an average applied tariff of 6.1 per cent for subheadings under HS 3904 (PVC). For a range of plastic substitute feedstock materials, the average applied tariff is also 5 per cent; the tariffs rise to 10 per cent for sisal and 13.3 per cent for paper and cardboard. For SUP product subheadings shown in Annex Table A4.6, applied MFN rates for Nigeria are much higher generally, averaging 20 per cent, with similar rates applying for non-plastic end-use product subheadings, with two exceptions where they fall to 15 per cent (folding paper boxes and cartons) and 10 per cent (glass bottles). Ceiling duty levels for Nigeria for the listed subheadings are unbound in most cases or else bound at the very high rate of 150 per cent. Only for unwrought aluminium are bound tariffs lower, at 40 per cent.

Nigeria benefits from preferential market access schemes such as the GSP applied by the European Union, Australia, Belarus, Canada, Japan, Kazakhstan, New Zealand, the Russian Federation, Switzerland, Turkey and the United States, as well as the United States African Growth and Opportunity Act (UNCTAD, 2018).

Nigeria imposes zero import duties on other ECOWAS member states in feedstock subheadings related to the listed plastics as well as plastic substitutes (WTO Tariff Download Facility, 2021). Since ECOWAS is a customs union, the MFN duties applied are the same as the ECOWAS Common External Tariff. The world's largest trading arrangement by membership, the AfCFTA, has "the potential both to boost intra-African trade by 53.2 per cent by eliminating import duties, and to double this trade if non-tariff barriers are also reduced" (UNECA, 2018, p. 1). The building blocks for the AfCFTA are regional economic communities such as ECOWAS and the EAC. Trading under the AfCFTA began on 1 January 2021. Table 6.1 illustrates the tariff liberalization schedule for categories of African member states, with all countries expected to liberalize 90 per cent of tariff lines over a period of 5 years, 10 years (for LDCs) or 15 years (for a specific group of G-6 countries (Ethiopia, Madagascar, Malawi, the Sudan, Zambia and Zimbabwe). More time is provided for liberalization of sensitive products (Table 6.2).

Table 6.1. Trade liberalization modalities under the AfCFTA

	LDCs	Non-LDCs	G-6
Full liberalization	90% of tariff lines	90% of tariff lines	90% of tariff lines
	10-year phase-down	5-year phase-down	15-year phase-down
Sensitive products	7% of tariff lines	7% of tariff lines	Not yet determined
	13-year phase-down (current tariffs can be maintained during first five years – phase-down starting in year 6)	10-year phase-down (current tariffs can be maintained during first five years – phase-down starting in year 6)	
Excluded products	3% of tariff lines	3% of tariff lines	Not yet determined

Source: Hartzenberg (2019).

Annex Tables A4.5 and A4.6 also include the import duties for relevant plastic and plastic substitute subheadings during the final implementation phase of tariff concession schedules submitted by ECOWAS as part of the AfCFTA liberalization process. Table A4.5 reveals that at the end of the implementation period duty rates will be free for nearly all the listed plastic and non-plastic substitute feedstock items. Exceptions include a 5 per cent duty rate for HS 3904.21 (other non-plasticized PVC) and HS 3904.22 (plasticized PVC), under plastic feedstocks. A 5 per cent duty rate also prevails for paper and paperboard (HS 4811.90) as well as for glass cullet and scrap (HS 7001.00) used in the manufacture of glass bottles. This may be compared with duty-free rates on the import of plastic scrap from the rest of Africa. This implies that import duties on feedstocks would not be relevant as a policy tool to restrict plastic imports or to favour manufacturing of non-plastic substitutes relative to downstream plastic products.

In end-use product subheadings as shown in Table A4.6, the scenario differs as ECOWAS excludes all listed end-use plastic products from AfCFTA liberalization. Certain paper products such as paper bags, paper cartons and paper plates and cups are also excluded, whereas other non-plastic product subheadings from AfCFTA countries attract a duty rate of 5 per cent, significantly less than the prevailing 20 per cent MFN rate. Therefore, with the exception of some paper products, import tariff policy could make imports of non-plastic substitute products relatively more attractive than imports of SUPs. This would need to be weighed against price competition from plastic products manufactured within Nigeria and the ECOWAS region.

6.3. Non-tariff measures

UNCTAD (2019, p. v defines non-tariff measures as “policy measures other than ordinary customs tariffs that can potentially have an economic effect on international trade in goods, changing quantities traded, or prices or both”. Such measures include technical measures such as sanitary and phytosanitary controls, technical measures for environmental purposes, quotas, price controls, export restrictions and contingent trade protective measures, as well as behind-the-border measures related to competition- and trade-related investment and restrictions on government procurement or distribution. UNCTAD (2021b) estimates that non-tariff barriers (NTBs) are at least three times more restrictive than regular customs duties.

It is beyond the scope of this paper to review the detailed application of these measures for all non-plastic feedstocks and end-use products. A review of the literature suggests that exporters of natural fibres such as the jute, abaca, coir, kenaf and sisal face numerous NTBs such as “strict packaging and labelling requirements, sanitary and phytosanitary measures, complex and bureaucratic customs and administrative procedures and import licensing requirements on the exports of processed fibre products” (Chang, 2013, p. 10). A notable measure includes a ban in many developed countries on the use of methyl bromide for fumigating crates containing fibre products that poses challenges for exporters because of the higher cost of alternative treatments to treat a range of pests. In addition, different standards and certification requirements are also demanded in importing countries. For example, Australia requires certification that sacks and woven fabrics made from industrially processed jute, abaca, coir, kenaf and sisal originate from pest-free crops, whereas in Japan blended products may require additional certification depending on the percentage of fibres used. In addition, private retailers may require that products meet standards related to environmental impact, health, safety, use of child labour and fair working conditions. Many of these concerns are regarded as legitimate or precautionary by importing countries and can be resolved only through exporter engagement and participation in bilateral and multilateral negotiations. In addition, capacity-building measures to help developing countries are also required (Chang, 2013).

Exporters of paper and paperboard-based articles need to be cognizant of voluntary sustainable forestry-related certifications such as the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC) that retailers can require, particularly in the European market. According to the FSC (2021), "forest management certification confirms that the forest is being managed in a way that preserves biological diversity and benefits the lives of local people and workers, while ensuring it sustains economic viability". The PEFC, an independent not-for-profit organization, certifies sustainable forest management and chain of custody (PEFC, 2021a). Some 71 per cent of wood and 83 per cent of pulp purchased by the European pulp and paper industry is reportedly PEFC- or FSC-certified (PEFC, 2021b).

Within Africa, the regional economic communities have set up institutional mechanisms for monitoring and resolving NTB issues. Annex 5 of the AfCFTA Protocol on Trade in Goods provides "a mechanism for the identification, categorization and progressive elimination of NTBs within the AfCFTA" (Erasmus, 2020, p. 3). The Protocol, according to the Trade Law Centre, "provides for institutional structures for the elimination of NTBs, the general categorization of NTBs, reporting and monitoring tools, and the facilitation of resolution of NTBs that are identified" (Erasmus, 2020). In South Asia, Article 7(4) of SAFTA similarly provides for annual reporting by contracting states of all non-tariff and para-tariff measures to be reviewed by a committee of experts to examine their compatibility with WTO provisions. The committee can recommend elimination or implementation of the measure in the least trade-restrictive manner. Article 8 of SAFTA provides for consideration of additional trade facilitation by contracting states, including the "harmonization of standards, reciprocal recognition of tests and accreditation of testing laboratories of Contracting States and certification of products" (Bangladesh Customs, National Board of Revenue, 2021, p. 6).

UNCTAD has also developed an AfCFTA online tool for reporting, monitoring and eliminating trade barriers. The private sector can directly report trade obstacles on the portal. NTB complaints are sent directly to formally nominated government officials (National Focal Points) who monitor and eliminate the barriers. National Focal Points have been trained on the use of the system and implementation is ongoing. The mechanism was formally launched by African Heads of State at the Extraordinary Summit of the African Union on 7 July 2019 in Niamey, Niger (UNCTAD, 2021b).

CHAPTER 7. REGULATORY FRAMEWORKS TO RESTRICT SUPS AND PROMOTE SUBSTITUTES FOR SELECTED COUNTRIES IN SUB-SAHARAN AFRICA AND SOUTH ASIA

Regulatory frameworks on the use of plastic products generally, and SUPs in particular, vary significantly around the world. The African continent has the largest number of countries that have enacted legislation to control the use of plastic bags (Nyathi and Togo, 2020). According to Adam et al. (2020, p. 1), "African countries are credited as having the harshest and most punitive anti-plastic bans in the world and perceived as being committed to addressing problems posed by SUPs". However, enforcement of such legislation remains a challenge in many African countries, owing to resistance from stakeholders (Nyathi and Togo, 2020). Implementation-related challenges are also seen in South Asia. This chapter presents some of the main features of the regulatory landscape of SUPs in sub-Saharan Africa, chiefly West and East Africa, and in South Asia. Particular attention is given to the report's case-study countries.

7.1. Regulations to address SUPs in sub-Saharan Africa

Africa is notable as the continent where the largest number of countries instituted a total ban on the production and use of plastic bags. Of the 25 African countries having introduced national bans, more than half (58 per cent) shifted into implementation between 2014 and 2017. Within Sub-Saharan Africa, most countries have adopted bans on the production, import, sale and use of plastic bags as the preferred instrument of choice, with a few exceptions such as Botswana that have adopted a levy on retailers (UNEP, 2018a). The scope of application as well as enforcement varies, and this section discusses the regulatory state of play within two regions of Sub-Saharan Africa, namely West and East Africa.

7.1.1. West Africa

In West Africa, 12 out of 16 countries, all members of ECOWAS, have policies to reduce SUPs. Eleven countries have instituted bans (Adam et al., 2020). Only one country, Ghana, has a market-based strategy: instead of a ban it has imposed an excise tax on imported semi-finished and raw plastic materials; however, a similar excise tax does not extend to locally produced SUPs. Given that commonly consumed SUP items such as polythene or plastic bags, plastic beverage bottles and sachet water packs are locally produced, experts have criticized the tax as having little impact on domestic SUP consumption and littering. Bans across West Africa have focused on particular types of SUPs. Whereas some countries – such as Burkina Faso, Cabo Verde and the Gambia – have targeted plastic bags, others – such as Benin, Guinea-Bissau, Mali and Togo – have targeted all non-biodegradable plastics. The scope of these bans mostly covers production, importation, distribution, sales, possession and use of SUPs, thereby affecting the entire value chain (Adam et al., 2020).

a. Nigeria

Nigeria, the most populous and largest country in West Africa, is notable for the absence of a ban on the use of SUPs. A 2013 plan to ban the production, importation, usage and stocking of low-density smooth plastic and packaging bags by 2014 did not materialize (Obateru, 2016). However, a bill to ban plastic bags is being considered. The Plastic Bags Prohibition Bill 2018 was passed by the House of Representatives in May 2019 to "prohibit the use, manufacture and importation of all plastic bags used for commercial and household packaging". The bill has two short sections, the first dealing with prohibition and the second with penalties (Box 7.1).

Although the bill has not yet received the assent of the president and is thus yet to be implemented (Akindele, 2020), local bans on SUPs have been introduced, such as that of the Lagos State Environmental Protection Agency (Oolasunkanmi, 2020). A notable aspect of the proposed bill is that it obliges the use of paper bags but does not lay out other options. This as well as the absence of market-based instruments such as taxes has been criticized as a fundamental flaw of the bill (Nwafor and Walker, 2020).

In October 2020, the Federal Executive Council approved new legislation on plastic waste management. Initiated by the Nigerian Federal Ministry of Environment, this national policy aims at improving plastic waste management and encouraging the development of a circular economy around plastic waste, including through improving plastic recycling (Magoum, 2020).

Box 7.1. Content of Plastics Bags Prohibition Bill 2018 of Nigeria

"Prohibition of Plastic bag (Section 1).

(1) the use, manufacturing, importation or sale of plastic bag is prohibited.

(2) A retailer shall offer a paper bag to the customer at the point of sale.

(3) Any –

a. Retailer who provides customer with the plastic bag at a point of sale is guilty of an offence.

b. person who manufacture plastic bag for the purpose of selling is guilty of an offence.

c. Person who import plastic bag whether as a carryout bag or for sale is guilty of an offence.

Penalties (Section 2).

(1) Any person found guilty of the offences under clause1 shall be liable on conviction to a fine not exceeding Five Hundred Thousand Naira (NGN 500,000) ($1,400) or to

(2) Imprisonment for a term not exceeding Three years or to both such fine and imprisonment.

(3) Any company or organization found guilty of the offence in clause 1 shall on conviction be liable to a fine not exceeding Five Million Naira (NGN 5,000,000) ($14,000)."

Source: Federal Republic of Nigeria (2018).

A notable aspect of SUP bans in West Africa, and indeed throughout the continent, is the lack of policies or laws that incentivize or support compostable or reusable alternatives to SUPs. The proposed Nigerian bill, for example, obliges retailers to offer a paper bag at the point of sale, but mentions no other substitutes.

7.1.2. East Africa

In other sub-Saharan African countries, bans on the production and importation of non-biodegradable plastic bags, rather than taxes or market-based instruments, have also been the preferred option to regulate SUPs. In 2017, the East African Legislative Assembly, an organ of the EAC, introduced a ban on the manufacturing, sale, importation and use of polythene bags under the East African Community Polythene Materials Control Bill 2016. This is the actual law to be followed by EAC member states (Burundi, Kenya, Rwanda, South Sudan, the United Republic of Tanzania and Uganda). A main aim and advantage of this regional approach has been to remove the possibility of competitive usage of polythene among member states; this could thus also serve as a useful template for other regions as an effective solution to address SUPs. Its collective objectives are to "promote the use of environmentally friendly packaging materials; preserve and promote a clean and healthy environment and land use management for sustainable development; prevent any type of pollution caused by polythene materials in lakes, rivers and oceans; protect infrastructure including drainage systems biodiversity and livestock; promote recycling; and brand the East African Community as green and clean" (Cocker and Maduekwe, 2020).

The bill also lays down penalties for violators: a fine not exceeding $5,000 or imprisonment for a term not exceeding 12 years or both. It also lists exempted polythene materials, which include those used in medical stores, industrial packaging, the construction industry, the manufacture of tents, the agricultural industry, mechanical and machine parts, the production of household wares and furniture, and plumbing, including water pipes (East African Legislative Assembly, 2016).

At the national level, several countries in East Africa have adopted varying degrees of restrictions on plastic bags. Some – such as Ethiopia, Mozambique and Uganda – have imposed a ban on the production, importation, possession and use of plastic bags <30μ (microns). The United Republic of Tanzania has banned both plastic bags and bottles, and Mauritius has a ban on the importation, manufacture, sale or supply of plastic bags, with 11 types of plastic bags for essential use being exempted. These include bags used for hygiene and sanitary purposes such as meat packing, those used for waste disposal, those used as integral parts of packaging and those manufactured for export (UNEP, 2018a).

a. Kenya

In March 2017, Kenya introduced a ban on the importation, production and sale of plastic bags used for commercial and household purposes through the publication of Gazette Notice 2356. The ban included both carry bags constructed with a handle and with or without gussets and flat bags constructed without handles and with or without gussets (Kenya Gazette, 2017). The penalties stipulated for violations included fines amounting to $40,000 and prison terms of up to four years for the importation, production and consumption of SUP bags (Adam et al., 2020). The National Environment Management Authority and the Ministry of Environment have further clarified the scope of the ban by publishing a set of guidelines as answers to frequently asked questions. Thus, for instance, the ban excludes industrial primary packaging as long as such packaging is not sold or distributed outside of an industrial setting. It also excludes disposal bags for handling biomedical and hazardous wastes and garbage-bin liners "subject to clearance by National Environment Management Authority, and provided that they are clearly labelled with the name of the entity manufacturing the product and the end-user" (Opondo, 2020).

The ban, which took effect on 28 August 2017, represents the third attempt to ban plastic bags after earlier attempts in 2007 and 2011. In 2007, Kenya attempted to ban the manufacture and import of plastic bags up to 0.03 millimetres in thickness in addition to imposing a universal 120 per cent tax on plastic bag use. In 2011, Kenya sought to ban plastic bags 0.06 millimetres thick. On both occasions the ban was not implemented (Goitom, 2017). According to analysts this was largely due to pushback from manufacturers and industry associations in Kenya, driven by concerns about employment losses among factory workers, workers in supply outlets, and street families engaged in the distribution of plastic bags (Behuria, 2019). In addition, the specifications on thickness could not be enforced effectively because of capacity constraints within the relevant state agencies, such as the National Environment Management Authority and the Kenya Bureau of Standards, as well as a severely underdeveloped recycling sector (Opondo, 2020).

Annual plastic manufacturing in Kenya expanded between 2010 and 2014 to 400,000 tonnes (Behuria, 2019). However, by 2017, pressure had built on the Government through local activists, organizations such as UNEP, the local press and social media, leading to the ban. Domestic businesses have continued to protest, pointing out through the Kenya Association of Manufacturers that the ban would result in the closure of 174 manufacturers and a loss of 60,000 jobs. They also contend that it would contribute to loss of exports, given that Kenya also exports plastics across the region. While manufacturers have claimed job losses of 60–90 per cent – including in industries that use plastics, such as agroprocessing – there is also a recognition that plastics cannot be a long-term investment prospect. Some Kenyan companies have also raised the issue of the lack of incentives for substitutes. Despite this, local companies have started producing cloth bags to tap into the market opportunity created by the new law. Alternative Energy Systems, for example, has set up operations in Kenya to manufacture synthetic diesel from plastic waste (Behuria, 2019).

In addition to the ban on plastic bags, laws on waste management, water, maritime, wildlife and fisheries management provide a broader framework for the implementation of measures for the prevention and control of pollution in the marine environment, including plastics-related pollution. The country's wildlife law, the Wildlife Conservation and Management Act, designates national parks, reserves and conservation areas for purposes of protection, conservation, and sustainable use. Exercising the powers under this act, the Cabinet Secretary (Minister) in charge of wildlife has also imposed a ban on plastic bottles, straws and related products in all national parks, national reserves, conservation areas and other wildlife designated areas. The scope of what is covered under "related products" is not clear (Opondo, 2020).

In 2014, the parliament adopted an Integrated Coastal Zone Management Policy that "aims at providing a framework for conservation of the country's coastal and marine resources and environment for sustainable development" (Opondo, 2020, p. 11). While recognizing the contribution of coastal and marine resources to the economy, it also acknowledges the threat to coastal and marine ecology from high densities of plastic waste and the need for interventions. Such interventions include actions by the national government to empower county (local) governments to effectively manage waste and mitigate environmental pollution. Some marine pollution (including plastic pollution strategies) listed in the policy document includes managing waste effectively, promoting public awareness of good waste management practices and enforcing waste management and pollution prevention regulations. The policy also complements the country's Shoreline Management Strategy which divides ocean coastline into 29 sedimentation cells for the purposes of putting in place targeted management measures to reduce risks of flooding, erosion, accretion, pollution by waste deposition (including plastic waste) and coastal destabilization (Opondo, 2020).

The Government is also pursuing various policy and legislative reforms to strengthen the governance framework for solid waste management. Kenya is developing EPR regulations that aim at establishing mandatory EPR schemes, including for plastic products (Ministry of Environment and Forestry, Kenya, 2020). The revised draft released by the Government in December 2020 covers a large number of products, such as paper and carton packaging as well as glass, aluminium products, lubricants, and rubber and rubber products. It also introduces additional EPR-related obligations such as raising awareness of management of post-consumer products that producers introduce in the market; carrying out product life-cycle assessment in relation to products to enhance environmental sustainability; supporting the establishment of markets for secondary raw materials; putting in place circular economy initiatives and other measures to reduce the health and environmental impacts of products; and funding research and development programmes on emerging technologies to improve material recovery (Compliance and Risks, 2021).

In 2019, Kenya also adopted various standards for recycled plastic packaging materials with the aim of protecting public safety and health and ensuring environmental protection. Various county governments are also taking steps to put in place local waste management policies and laws. For example, under the waste management law of the Nairobi City County, waste has to be segregated by the following categories: organic, plastics, paper and metals. In practice, however, this law as well as other obligations on "generators of waste" to reduce and manage waste is implemented only by businesses, which are easier to monitor, and are non-existent at the household level. There are also penalties for littering. Although the prohibition is important as a tool for curbing plastic waste proliferation in streets, wastewater drains and public places and for controlling the levels of waste entering the oceans, countywide enforcement of the prohibition remains a challenge. A general prohibition on pollution of the marine environment (including dumping of plastic waste such as fishing gear) can also be interpreted from provisions in the maritime, wildlife and fisheries laws related to the conservation, management, development and protection of marine, fisheries and wildlife resources within the country's maritime zone (Opondo, 2020).

Following the ban on plastic bags, a possible move to further regulate the use of PET bottles also spurred efforts by the Kenya Association of Manufacturers, working with the Ministry of Environment and Forestry to establish a joint framework of intervention. This led to the incorporation of the Kenyan PET Recycling Company (PETCO), which has established a few collection points in shopping malls in Nairobi to enable consumers to drop off used PET bottles for recycling. It plans to expand such points at retail outlets, fuel stations and residential areas in the city (Opondo, 2020). PETCO is a voluntary, industry-led, self-regulation scheme, whereas the introduction and implementation of the EPR scheme will lead to a mandatory regulatory framework for industries to take back plastic packaging, including PET bottles (Opondo, 2020).

Implementation of the ban in Kenya seems to have had some effect in deterring offenders, with several arrested, prosecuted, convicted and imprisoned or fined for ban violations. Plastic bags are no longer dispensed publicly at business outlets, and streets and public places are cleaner and free of plastic bags. Nevertheless, illegal plastic bags are still imported in certain pockets from Somalia, the United Republic of Tanzania and Uganda.

b. Rwanda

Rwanda is often cited as a successful African example of a plastic bag ban. The ban on the production, use, importation and sale of all polyethylene bags was adopted in 2008. It faced challenges in its early implementation phase, as a black market developed for plastics bags. Subsequently, Rwanda enforced strict penalties, including heavy fines and imprisonment, for possession and use of plastic bags; they have now been largely replaced by paper bags (Freytas-Tamura, 2017).

In 2019, the 2008 plastic law (Law No. 57/2008) was repealed and replaced by Law No. 17/2019, which came into force on 23 September 2019. The new law extends the prohibition on plastic carry bags to SUP items other than for "exceptional reasons." The law (Art. 2(6)) defines plastic as "a material derived from petrochemicals that are lightweight, soft and non-compostable" and SUPs as "a disposable plastic item designed to be used once before it is discarded or recycled. Single-use plastic items include plastic carry bags, oxo-degradable plastics and other items whose part is made from plastic material" (Art. 2(1)). The law includes an exception to the prohibition for "home-compostable plastic items" and "woven polypropylene." The law does not define "home compostable", however it defines "compostable plastic material" as "any material made from single-use plastic or plastic carry bag made from plant-based synthetic materials capable of undergoing biological decomposition in natural conditions" (Art. 2(2)). The law also includes some aspects of EPR requirements, including a provision for the imposition of an environmental levy on imported SUP items and goods that come packaged in plastic (Art. 5) and requiring "[e]very manufacturer, wholesaler or retailer of plastic carry bags or single-use plastic items must put in place mechanisms to collect and segregate used plastic carry bags and single-use plastic items and hand them over to the recycling plants" (Art. 6) (ELaw, 2021a).

With this new law, Rwanda is set to become the first East African country to ban all SUPs. The nation aims to achieve this by 2021 so a to become the world's first country free of SUPs. Manufacturers found in violation of the law are liable for penalties including closure of activity and fines of RF 10 million ($9,940). Similarly penalties for wholesalers and retailers have been set at RF 700,000 and RF 300,000, respectively; importers in violation of the law are subject to a penalty of 10 times the value of the plastic carry bags and single-use items in possession. An individual disposing of plastic bags and SUP bags in an unauthorized public or private place is liable to an administrative fine of RF 50,000. For those individuals permitted under exceptional circumstances to use plastic carry bags and SUPs or to treat waste, the fine for unauthorized disposal is even higher, at RF 5 million (ELaw, 2021b).

7.2. Regulations to address SUPs in South Asia

The South Asia region comprises Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. All these countries except for Nepal have some form of ban on plastic bags, at either the national or the municipal level. Maldives does not have a ban but has instead imposed standards for imported plastic bags. Prohibitions in the other countries focus mostly on the material, thickness and degradability of SUP bags.

7.2.1. India

The scenario in India is determined by the federal nature of governance. In June 2018, Prime Minister Modi announced the intention to phase out SUPs by 2022. Several states and municipalities have already introduced varying degrees of bans and restrictions, beginning with a ban on plastics bags introduced by Himachal Pradesh as early as 2009. In 2017, the city of Delhi expanded its ban to include bags, cutlery, cups and plates. By early 2019, local governments in more than half of India's 29 states and 7 union territories had introduced some form of legislation targeting SUPs, with bans on thin plastic bags being the most common measure. Enforcement has varied across states, with some – such as Maharashtra and Tamil Nadu – pursuing particularly effective measures and penalties for violations. In Tamil Nadu, for example, disposable cutlery, laminated paper cups, plastic bags and 11 other plastic items have been banned, and the Tamil Nadu Pollution Control Board monitors for possible incursion of banned items from other states. The ban has been complemented by additional measures such as consumer awareness campaigns and educational outreach programmes in schools and universities (Sampathkumar, 2019).

There have also been initiatives to promote sustainable alternatives by the private sector such as the food delivery app companies Swiggy and Zomato that provide restaurants with sustainable packaging alternatives made from sugarcane bagasse, bamboo and palm leaf, as well as paper solutions and glass. Zomato offers consumers the option of not ordering cutlery, and Swiggy has taken up EPR for 100 tonnes of plastic a month (Dash, 2019). Street vendors in

Tamil Nadu have also started switching to sustainable alternatives such as paper and plant fibres to serve food and to paper straws. Women's self-help groups in the state have seen a huge increase in demand for bags made of cotton, and there has been a rise in the use of metal containers. Rural residents have also benefited from the rise in demand for natural materials such as banana leaves (used in lining plates), hollow papaya stalks (for straws) and lotus and arecanut leaves (packaging material). Yet, enforcement has not been as effective in cities such as Delhi and Kolkata (Sampathkumar, 2019).

India is working on completely phasing out SUPs by the second half of 2022. To enable this, the Ministry of Environment, Forests and Climate Change proposed the Draft Notification Plastic Waste Management (Amendment) Rules, 2021 on 13 March 2021. The amended rules draws on the Environment (Protection) Act, 1986 and aim to eventually ban the manufacture, use, sale, import and handling of SUP items. The notification solicits comments and suggestions from stakeholders and general public. Once finalized and adopted, the ban is scheduled to take effect in three phases.

The first phase will commence on 30 September 2021, with a requirement that carry bags made of virgin or recycled plastic have a thickness of more than 120 microns. Compostable plastic bags are exempted from this requirement. The increased thickness is expected to facilitate collection and recycling of the bags. The second phase is to commence on 1 January 2022, with a ban on six categories of SUPs: earbuds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks and polystyrene for decoration. The third phase, slated to start on 1 July 2022, will extend the ban to include plastic plates, glasses, cutlery (plastic forks, spoons, knives, trays), plastic stirrers, packaging films on sweets boxes, invitation cards, cigarette packets and plastic and PVC banners with a thickness of less than 100 microns.

Public consultations on the draft notification were pursued for 60 days from the release of the draft notification, and plastic manufacturers and brand owners will be provided time to find alternatives. The higher cost of environmentally friendly alternatives compared with plastic may also hinder implementation of the policy (Ministry of Environment, Forests and Climate Change, India, 2021; Jestin, 2021).

7.2.2. Pakistan

The Pakistan Environmental Protection Act, 1997 (revised in 2013), imposed a ban on the manufacturing, sale and use of non-degradable scheduled plastic products. However, the ban is still limited to specific cities and the Islamabad Capital Territory. In 2019, the Government issued a special regulatory order specifically for the Islamabad Capital Territory, based on best practices around the world, to improve the effectiveness of enforcement (Ministry of Climate Change, Government of Pakistan, 2019; Gul, 2020; UNEP, 2018a). In addition to penalties for violators, the order also contains some exceptions for the manufacture and import of flat polythene bags for industrial packing, primary industrial packing, municipal waste, hospital waste and hazardous waste. It also places obligations on manufacturers and importers to develop and maintain a plan for collecting and recycling flat bags under the principle of EPR, as well as to submit a detailed annual report on the previous year's recycling activity. Provisions exist for setting up collection points to facilitate recycling as well as a requirement to print the name of the manufacturer and importer on plastic bags (Ministry of Climate Change, Government of Pakistan, 2019). Although these are innovative measures, they have not yet been applied countrywide. There are also no specific mandates or incentives for the use of substitutes.

7.2.3. Sri Lanka

In 2017 Sri Lanka banned the import, sale and use of polyethylene bags with a thickness of less than 20 microns as well as XPS containers (Special Gazette 2034). The ban was not effectively enforced and in October 2020 the Cabinet of Ministers of the Parliament approved a proposal to ban a range of products, to take effect 1 January 2021. These included chemicals or pesticides packaged in PET and PVC containers, sachets made of polythene and plastics less than 20 ml or 20 g (excluding food and medicine), various inflatable toys made of plastic (excluding balloons, balls and floating toys) and plastic cotton buds (excluding hygiene products) (UNEP, 2018a; Kumara, 2020).

Biodegradable and non-biodegradable waste is collected and segregated across Sri Lanka, with the latter usually dumped on open ground. Existing recycling facilities are limited, and there is no national-level data on their capacities. Of the two recycling facilities in Sri Lanka one is dedicated to converting PET bottles to yarn – one of only two such facilities in the world. Although drinks companies in Sri Lanka such as Coca-Cola have decided to use PET due to its recyclability, the lack of adequate recycling facilities or systematic recollection facilities at the municipal level were identified as challenges. However, some initiatives on solid waste management and the use of alternatives have started to gain momentum. A waste resource recovery centre was set up by Unilever in 2019 in collaboration with INSEE Ecocycle Lanka to collect and segregate mixed solid waste and repurpose plastic for recycling and upcycling with plans to increase capacity from 500 to 1,000 tonnes per month (Justin, 2020; Daily News, 2021).

In 2008, the Central Environmental Authority also initiated a national solid waste management programme – called Pilsaru – with a $3.5 million grant, but the programme faced issues such as the need to optimize waste collection, provide training and microloans to help waste pickers (mostly women), and carry out clean-up campaigns and litter-collection education drives. Companies have also been moving towards alternatives. Unilever has announced intentions to move towards 100 per cent recyclable plastic, and Aquafresh, a drinking-water company, plans to shift to glass bottles sourced from plants in Sri Lanka. The Sri Lankan Government is also exploring ways to meet market demand through environmentally friendly products and has started extending support to small and medium-sized enterprises that produce biodegradable food packaging. Alternatives such as food packaging made from banana waste are also being explored. Technology and investment for the use of advanced moulds to produce commercial products could also facilitate greater participation by small firms in the production of alternatives (Justin, 2020).

7.2.4. Maldives

Maldives, located in a sensitive marine atoll rich in marine life, relies on imports for its plastic needs. In December 2020 it passed an amendment banning the import of SUPs. The 18th amendment to the Export-Import Act (No. 31/79) was ratified on 22 December 2020 by the president and brought into effect immediately with publication in the Gazette. The amendment also vests the president with authority to compile and publicize a list of goods to be classified as SUPs, including the release of a temporary list of banned items. The move follows an earlier resolution in 2019 by the Parliament to completely phase out SUPs by 2025 as well as subsequent presidential approval of a plan by the Ministry of Environment to phase out SUPs earlier, by 2023 (Edition, 2020). The plan, to be implemented in phases, was drafted by a diverse committee of experts, policymakers and civil society representatives on the basis of public and stakeholder consultation sessions. On 30 December the Maldives Presidency issued a decree banning the import of a list of SUPs whose imports were originally to be banned as of 1 June 2021. The prohibited items are drinking straws; plates, cutlery and stirrers; XPS lunch boxes; 30 x 30 cm carrier bags; betel nuts in plastic wrapping; coffee cups that hold less than 250 ml; cotton wool buds; 50 ml and smaller toiletry bottles; and PET beverage bottles that hold less than 500 ml. After 1 December 2022, importation of carrier bags of less than 50 micron thickness, 50–200 ml toiletry bottles and 1-litre PET beverage bottles will also be prohibited (President's Office, Republic of Maldives, 2020).

The Single-Use Plastic Phase Out Plan is comprehensive in its scope and coverage, with a vision of reducing marine litter in Maldives using strategic policy instruments. Among its short-term objectives, it aims to achieve 85 per cent collection of SUP waste by 2023 to prevent leakage into the marine environment. Among its objectives for 2030, the policy includes the provision of a wide variety of affordable, and accessible non-plastic alternatives …, the establishment of national level regulations to promote circular economy for different sectors … [and] the establishment of minimum one plastic recycling facility … that has pre-sorting, sorting and recycling technologies. The policy stipulates that products labelled as bioplastics, compostable or biodegradable are also to be phased out if they are single-use. It includes six policy applications: (i) banning the import, production and sale of specific SUP products; (ii) applying market-based instruments; (iii) improving national waste data and setting national collection and reduction targets for key SUPs; (iv) establishing EPR; (v) providing sustainable alternatives; and (vi) conducting education and raising awareness. Among import-related measures, the policy provides for tariffs of up to 400 per cent on certain SUPs such as plastic bags of a certain thickness, PET bottles and raw materials. It also provides for zero duties on certain types of plastic substitute articles, including (i) bags made from reused fabric; (ii) reusable bags made calico, hemp, jute, cotton and canvas; (iii) compostable bags that are third-party certified according to UNI[10] EN 13432 standards and ASTM 6400; (iv) beauty and household cleaning products free of plastic packaging; (v) metal, silicon, bamboo and other non-plastic straws; (vi) bamboo or plastic-free toothbrushes; (vii) water filtration systems; and (viii) reusable diapers. Maldives is also seeking to promote the diffusion of filtered water by setting up plastic-free or reusable containers for water, including in tourist spots, and water refilling stations and filtration systems[11] (Ministry of Environment, Republic of Maldives, 2020).

In addition to identifying plastic substitutes available for specific articles, the policy document also provides for levies at the point of sale for certain plastic items and a business facilitation programme. This first involves the identification and registration of key importers and businesses providing alternatives and then the provision of facilitation and other incentives (Ministry of Environment, Republic of Maldives, 2020).

The policy further provides for the introduction of new or separate HS codes for a large number of SUPs, to enable data analysis and facilitate the setting of reduction targets. In addition, as a contribution towards the circular economy, the policy discusses the setting up of a deposit refund system for recyclable beverage containers to enable high collection rates, based on models followed in the European Union and in other small island States such as Kiribati and Palau, noting that such systems have resulted in collection rates exceeding 80 per cent. Targets for setting up and implementing a deposit refund system by December 2021 are also laid out in the policy (Ministry of Environment, Republic of Maldives, 2020).

7.2.5. Nepal

Nepal has seen several initiatives to ban the use of plastic bags at the municipal level, especially since 1999 when under the Local Self-governance Act 1999 local bodies were given the right to ban goods and activities that damage the environment. In 2011, the Plastic Bag Regulation and Control Directive was introduced, prohibiting the production, import, sale, distribution and use of plastic bags less than 20 microns in thickness. In 2015, another ban targeted the manufacture, sale and import of all polythene bags less than 30 microns outside Kathmandu and less than 40 microns in the Kathmandu valley. The bans have largely been ineffective, for reasons that include their partial nature and the costs entailed in monitoring them, the cheap cost of plastic bags, the lack of effective penalties, pushback by the domestic plastic manufacturing industry, the flouting of thickness laws by local manufacturers and illegal imports from China and India.

More recently, the COVID-19 pandemic has induced greater use of plastic packaging. There has also been insufficient discussion of plastic alternatives, although in earlier decades paper and jute bags were reportedly widely used in Nepal. There is a need for government incentives and/or support to assist plastic manufacturers to shift towards alternatives and to encourage better waste segregation for the collection of plastic bags for recycling as well as the establishment of plastic recycling facilities (Malla, 2019; Awale and Kumar, 2020; Bharadwaj, 2016). Nepal also introduced a ban on SUPs in the Everest region starting in January 2020 although the ban does not apply to plastic water bottles (Katz, 2019). The private sector has also stepped in to provide alternative solutions for single-use items. GrowNepal offers cotton and jute bags that are reusable and washable and exported worldwide. DeepPaper Bags supplies imports from India made of cornflour and cellulose that degrade in 15 days when in contact with soil and sunlight.

7.2.6. Bhutan

Bhutan introduced a ban on plastic bags in 1999. Two subsequent attempts to reinforce it, in 2005 and 2009, failed due to lack of follow-up. The ban was reinforced in 2019 but is limited to plastic carry bags and doma[12] wrappers, with the use of transparent plastic allowed for wrapping vegetables, snacks and other edibles, including processed foods such as noodles and biscuits, for which no alternatives exist. As in many South Asian countries, there is a lack of a proper waste management infrastructure and systems, including waste segregation at source; however, most waste is landfilled. The ban thus also includes biodegradable plastic bags, which need special facilities for composting. The ban extends to businesses, with penalties for offending establishments but not for customers, who can carry and reuse their own bags. There is also an attempt to encourage people to use plastic alternatives such as biodegradable jute bags. According to reports, the ban is not effectively enforced, and plastic carry bags and doma wrappers are still available in markets (Business Bhutan, 2020; Daily Bhutan, 2019; Kapinga and Chung, 2020).

7.2.7. Bangladesh

A motion for a ban on plastic was introduced in Bangladesh in 1993 following a nationwide clean-up campaign kick started in 1990 by ESDO. The motion did not gain traction until 1998, when the role of plastic waste in worsening the impact of floods led to a ban on plastic bags. The proposal was taken up by the Ministry of Environment and Forests and received the assent of the Senate and the Parliament. The ban was initially designed to be enforced only in the national capital region. In 2002, it was transformed into a national ban, following strong public support and a nationwide campaign (Kapinga and Chung, 2020). This made Bangladesh one of the first countries in the world to ban the use of plastic bags (Paul, 2020).

The penalty for violation of the ban involving production, importation and marketing is a 10-year prison sentence or a fine of BDT 10,000 ($170 at 2002 exchange rates) or both. For the sale, exhibition, storage, distribution, transportation or use of plastic bags for commercial purposes, a six-month prison sentence or a fine of BDT 10,000 is imposed (Kapinga and Chung, 2020).

In addition, Bangladesh has adopted other measures to strengthen the effectiveness of the plastic ban. These include promoting alternative materials such as jute through mandatory use requirements, introducing fines on the improper use and disposal of polythene bags, enforcing environmental laws with regard to polythene production and consumption, and absorbing workers in plastic manufacturing units into the jute and textile industries. A polythene factory owner filed a petition in the Bangladesh High Court opposing the measure, and the court ruled against the petition on the grounds that the lives of Bangladeshis outweighed the employment of a few thousand employees in polythene factories. The Government extended loans and other financial benefits to affected factory owners to incentivize them to switch to other enterprises and also provided rehabilitation for laid-off workers (Kapinga and Chung, 2020). Specific examples for the promotion of alternatives are the Jute Packaging Act – 2010 and the mandatory Jute Packaging Rule 2013, which made it mandatory to use jute packaging for paddy, rice, wheat, corn, fertilizer and sugar. This was subsequently extended to additional products such as chilli, turmeric, onion, ginger, garlic, pulses, coriander, potato, flour and husk, crude flour (ata) and rice bran, poultry feed and fish feed. These rules have not been extended to cover mandatory use as shopping bags (Financial Express, 2021; Mustanzir, 2020). Despite the various measures introduced, there have been problems with effective enforcement of the ban on SUP packaging as well as the mandatory rules on jute packaging.

In January 2020, the Bangladesh High Court ordered the Government to ban the use of SUPs in coastal areas and in hotels and restaurants within a year and to strictly enforce the ban on polythene bags under the current law (Paul, 2020). In April 2021, the Bangladesh environment ministry ordered immediate measures be taken to stop the use of SUPs in coastal areas within a year. Divisional commissioners were asked to stop the use of SUPs in hotels and restaurants across the country within a year. Mobile courts were also authorized to operate against the illegal production and sale of plastic (Kamol, 2021). Factors identified for the widespread use of SUPs include their cheap price, the lack of affordable alternatives and weak policy enforcement. The limited production of alternatives and lack of awareness have also been cited as factors hindering the uptake of alternatives (LightCastle Analytics Wing, 2020).

Despite the low degree of economic integration in South Asia relative to many other regions, it has launched a regional initiative to tackle marine plastic pollution. The South Asia Co-operative Environment Programme (SACEP), an intergovernmental organization established in 1982, aims "to promote and support protection, management and enhancement of the environment in the region" (SACEP, n.d.). The programme has convened member states to tackle regional environmental issues, more recently on marine plastic pollution. It has prepared the "world's first regional marine litter action plan (endorsed by all ocean-facing South Asian nations) and a regional solid waste management action plan (endorsed by both mountain- and ocean-facing nations of the region)" (MarketScanner News, 2021). The marine litter action plan provides that South Asian countries shall "review the effectiveness of existing economic and marketing base instruments for managing solid waste and marine litter in the SAS countries" (Objective 3.8.1, Action (i) - 01), "introduce some economic instruments such as financial disincentives (penalties, taxes and charges for plastics and polythene) to discourage market behaviours that may contribute to reduce the marine litter" (Objective 3.8.1, Action (i) - 02) and "introduce financial incentive schemes for polythene and plastics (deposit refund schemes, subsidies and direct payments, price differentiation) to stimulate behaviours of customers on polythene and plastics" (Objective 3.8.1, Action (i) - 03) (SACEP, 2018). Although the action plan could thereby indirectly incentivize the use of substitutes, there is no direct incentive for the use of plastic substitutes.

7.3. Regulatory gaps and challenges in sub-Saharan Africa and South Asia

Although Nigeria still lacks a regulatory framework addressing SUPs, the regulatory response to SUPs in Kenya and Bangladesh has faced both design- and implementation-related gaps and challenges (Table 7.1).

Table 7.1. Bangladesh and Kenya: Design and implementation challenges in SUP regulations

Country	Design-related challenge	Implementation-related challenge
Bangladesh	• Pricing-related measures to disincentivize the use of all SUPs are absent. • Specific incentives or promotional measures for environmentally friendly or fully compostable substitutes are lacking – e.g. the mandatory use of alternatives for packing specific condiments is not extended to all uses. • Effective EPR requirements are lacking.	• Effective enforcement of SUP plastics bag ban throughout the country is lacking. • Alternatives cost more than SUPs.
Kenya	• Consensus is lacking on the scope of legislation; i.e. a need for specific clauses and provisions that target plastics specifically versus focusing on broad provisions on solid waste management and marine pollution prevention and their effective enforcement[a]. • In legislation the scope of prohibited activity is often not clear, which carries the risk of legal challenge and uncertainty and lack of predictability.[b] • The scope of covered plastic items subject to the ban in wildlife parks, reserves and conservation areas is not clear. This could pose challenges for implementation and enforcement once the ban takes effect. • Draft EPR regulations are still a work in progress and await finalization. • Specific incentives or promotional measures for environmentally friendly or fully compostable substitutes are not mentioned or included.	• Capacity constraints are a major impediment to effective management of plastic waste pollution. • Inadequate facilities for waste collection, transport and disposal and lack of awareness about good waste management practices such as waste segregation lead to inefficient waste collection and disposal. Open dumpsites are prevalent in many developing countries, such as Kenya. • Structured waste management services are lacking, particularly in slums and rural areas. • Better coordination among state agencies as well as greater resources for monitoring and enforcement are needed for national and county government agencies and departments to more effectively discharge their legal mandates (Opondo, 2020). • There is a need for public awareness to generate positive behavioural change regarding plastic waste management.

Sources: Opondo (2020), LightCastle Analytics Wing (2020), Begum (2021).

a The first approach is favoured by environmentalists and regulatory agencies while industry favours the latter. The Kenya Association of Manufacturers also favours a self-regulation mechanism instead of government regulation.

b For example, although the Gazette Notice "bans the use, manufacture and importation of all plastic carrier bags and flat bags used for commercial and household packaging, it is silent on possession, transportation, distribution, retail/sale and exportation of such bags" (Opondo, 2020, p. 16). Despite this, Kenyan authorities have interpreted the ban to include all elements and also have enforced the notice and prosecuted offenders accordingly (Opondo, 2020).

From the perspective of greater deployment of substitutes, a review of regulations on SUPs in sub-Saharan Africa and South Asia reveals three major gaps that will need to be addressed.

i. Specific incentives or promotional measures for environmentally friendly or fully compostable substitutes as replacements for SUPs are lacking. Taking into account the availability and cost of environmentally friendlier alternatives, particularly when pursuing bans, is likely to reduce opposition from stakeholders, especially consumers and users of SUPs that may be affected (Opondo, 2020). Providing specific incentives or regulatory support for the domestic production or import of substitutes could create conditions for a wider uptake of plastic alternatives.

ii. A holistic regulatory framework that covers all aspects of the value chain of SUPs from raw materials to end-of-life management is missing. Also needed are policy frameworks and laws mandating or supportive of reuse and take-back systems. This would be significant in the deployment of materials such as glass and aluminium and the offering of services such as water-refilling outlets.

iii. There is a capacity gap in all three countries related to infrastructure, resource and funding constraints that often impede effective enforcement of SUP laws where they exist.

From a regulatory design perspective, one noteworthy framework that could serve as useful template for other developing countries is that of the Maldives phase-out policy for SUPs. This policy takes a holistic approach, addressing various aspects related to the phase-out of SUPs. These include not only restrictions on domestic production, sale and imports, but also the use of market-based instruments, waste data collection, SUP collection and reduction targets, EPR and the provision of sustainable alternatives. These alternatives are also supported through zero import duties, specification of international standards, and education and awareness programmes. Elements of the Maldives SUP regulatory framework could be suitably integrated and adapted, depending on local conditions, into the policy and regulatory frameworks of Bangladesh, Kenya and Nigeria as these countries further strengthen their regulations.

CHAPTER 8. CONCLUSIONS AND POLICY OPTIONS

This report has attempted to bring together diverse streams of information, data and analysis drawn from techno-economic surveys, LCAs, trade flow and import duty analysis, and RCA assessments to guide countries in sub-Saharan Africa and South Asia, particularly in Bangladesh, Kenya and Nigeria, in electing suitable options to replace commonly used SUP products. This chapter sets out some of the main takeaways and proposes domestic and trade policy options that could be explored. It also highlights examples of international policy and governance initiatives that could play a supportive role.

The conclusions and policy options are clustered under three themes: (i) selecting the right SUP substitutes, (ii) building an effective ecosystem and enabling regulatory environment to address SUP pollution and encourage a circular economy, and (iii) harnessing trade opportunities. Specific examples of regional and global governance initiatives that could be supportive of efforts to transition away from SUPs and towards non-plastic substitutes are highlighted in boxes.

8.1. Selecting the right SUP substitutes

Selecting the right SUP substitutes will depend on numerous factors that may change over time. SUPs have gained immense popularity for their inherent characteristics and low prevailing prices; however, poor SUP biodegradability and plastic waste mismanagement have led to increasing pollution of soils, freshwater, the air and the oceans. As this report makes clear, this mismanagement is driven by two factors: first, a relatively rapid shift from using natural or durable materials to SUP products in societies where consumer awareness and motivation to discard such products responsibly has not developed as quickly as the shift in usage, and second, a lack of resources to set up systems and infrastructure for handling SUP waste where it is generated.

These two drivers can evolve favourably to allow for better management of SUPs in developing countries. Yet, the short- to medium-term reality is that consumer behaviour and infrastructure for handling plastic waste (including bioplastics), such as sorting at source and industrial composting, may lag in many countries for a while. Plastic recycling facilities are not developed at scale and also suffer from limitations in their ability to handle a diversity of polymer streams, mixed polymer types or contaminated plastics. In many cases, it may be more advantageous from both an environmental and a circular economy perspective to reuse certain types of plastics as well as non-plastic substitutes such as glass and aluminium. Nonetheless, the reality is also that such reuse models and systems exist to only a limited extent in developing countries and may not be convenient in all consumer environments. In addition, it is crucial to note that impacts such as clogged drainage systems or riverine or marine pollution are currently not captured by LCA methodology. The seemingly better sustainability performance of plastic in LCA studies must be seen in that context.

Consequently, at least for the short to medium term, the on-the-ground realities in many countries in South Asia and sub-Saharan Africa, including Bangladesh, Kenya and Nigeria, will necessitate a switch from SUPs – starting with the most problematic products – to non-plastic substitutes. These alternatives could consist of either (i) fully compostable natural materials or (ii) non-plastic substitutes (a) that are fully recyclable; (b) that provide an incentive for post-disposal collection, including by workers in the informal sector for further recycling; and (c) for which recycling infrastructure is relatively better developed.

It was based on these considerations that the identification of suitable SUP options was pursued in this paper. The process of identification revealed some important takeaway lessons.

Supportive initiatives

Strengthen data-gathering and LCA inventory development: The lack of adequate inventory data for specific feedstocks and countries is always a challenge to carrying out LCAs. This is also the case for Bangladesh, Kenya and Nigeria. Countries may wish to explore initiatives in collaboration with global partners and relevant organizations to gather, store and update inventory data that can aid in conducting a comprehensive LCA in the future for promising SUP substitutes.

8.1.1. Balance techno-economic, sustainability and trade considerations

The selection of viable SUP substitutes should involve an assessment of techno-economic considerations such as adequate domestic resource availability, feedstock pricing, competitiveness relative to plastic feedstocks and products, presence or absence of a manufacturing base and adequate technology, an established market, and potential for domestic employment generation and rural development. It also involves environmental sustainability considerations based on LCA metadata and country-specific data where possible. The life-cycle impact can could depend on numerous factors, including type of energy used in manufacturing, water intensity of crops, existence of reuse and take-back models, consumer behaviour, waste disposal practices, and industrial composting and recycling infrastructure. Finally, trade considerations can also be included, such as current export performance, established export markets or potential for tapping into new regional and global markets. Calculation of RCA scores in specific feedstocks and products can also help in identifying feedstocks with better export or import potential.

An application of these considerations is illustrated in Annex Table A6.6 which compares products selected on the basis of techno-economic considerations for Bangladesh, Kenya and Nigeria against outcomes from LCAs and trade-related indicators analysed in this report. The Annex VI tables can be accessed at the SMEP Trade and Pollution Dashboard under Reports at http://bit.ly/SMEP_UNCTAD. Although natural products do not have end-of-life challenges similar to those of plastic, they are more land- and water-intensive and their cultivation or extraction can adversely affect the environment through agrochemical use or mining activity. In addition, they release considerable amounts of greenhouse gases as they decompose, thereby contributing to climate change.

A key lesson emerging from the results of the LCA exercise is that high scores on all indicators are not usually possible and countries may thus need to balance different considerations. For example, despite screening LCAs showing greater negative environmental impact, cotton has been retained as a feedstock option for grocery bags in Bangladesh, Kenya and Nigeria because of its well-established presence and widespread availability and use. Furthermore, many variables that affect techno-economic viability and sustainability can change over time. For example, recycling and industrial composting facilities may expand, reuse models could become more common and environmental regulations could be introduced to reduce adverse environmental impacts from production – e.g. rules requiring paper and paperboard to be sourced from sustainable forestry or recycled sources.

8.1.2. Explore the potential to exploit agricultural by-products and post-harvest agricultural waste

Another important implication of the techno-economic assessment and LCA is that agricultural by-products and post-harvest waste such as wheat straws and banana and areca leaves could be promising natural feedstock sources for products such as straws, food containers and plates. There are several reasons. First, the impacts associated with their cultivation are significantly lower as a result of apportioning of impacts done because they are by-products of major crops that are already grown for food. Second, they could have a positive impact through the avoided impacts of crop waste disposal. Third, they could provide a livelihood by serving as a raw material for cottage or small-scale industries making end-use items and also as an alternative source of income for small farmers if main food crops fail as a result of climatic reasons or pests – a common occurrence in many developing countries. Crops such as bananas, bagasse, corn, rice husks and wheat are grown on a commercial scale globally, so procuring adequate volumes of such feedstocks for product manufacturing may be less of a challenge.

8.1.3. Invest in expanding manufacturing capacity and technology

Bangladesh, Kenya and Nigeria already have a well-established manufacturing capacity that can be utilized to produce non-plastic end-use items from feedstocks. Nevertheless, there is a need for innovation and modernization to enable improved and more affordable alternatives with attributes that help production expand at scale and that better compete with SUPs.

Production of agricultural by-products such as banana fibre remains nascent in Bangladesh. Challenges related to technology, innovation, supply chain or sourcing, and transportation of raw materials will need to be overcome to enable production of standardized quality products such as food containers at scale. For uses such as wrapping food, minimal processing is required and the feedstock may be more easily deployed. Similarly, in the case of areca leaves, although some machines in Bangladesh can be used to process areca leaves, they are slow and the end product is still finished manually. Although manual-based production methods can certainly offer prospects of employing more workers, they can also hold back lower-priced production at scale. A balance may therefore need to be struck. Ideally, greater production at scale can enable more workers to be trained and employed. Governments should therefore explore the possibility of expanding manufacturing capacity and deploying modern technologies, particularly for processing feedstocks such as agricultural by-products and waste.

Demand for the products manufactured from agro-waste could also be driven through specification of desirable criteria for alternative materials, such as being made from post-harvest agro-waste where feasible, as well as through supply chain management and preferential procurement by government entities.

Supportive initiatives

Harness bilateral and multilateral aid and technology initiatives in the agriculture sector: Numerous donor-led initiatives aim to strengthen the agriculture sector in developing countries, reduce post-harvest losses and expand agroprocessing. Some of these initiatives could also be tapped into and harnessed towards manufacturing SUP substitutes from agro-waste. An example is UNIDO's 3ADI+, the Accelerator for Agriculture and Agroindustry Development and Innovation (UNIDO, 2021). The initiative is "a joint value chain and market systems development programme" led by the FAO and UNIDO and UNIDO's Circular Economy Initiatives, especially the production of biobased polymers led by UNIDO's Department of Agribusiness (UNIDO, n.d.).

8.2. Building an effective ecosystem and enabling regulatory environment to address SUP pollution and encourage a circular economy

Creating an effective ecosystem and enabling environment to address SUP pollution and encourage uptake and diffusion of SUP substitutes is critical. This section outlines important considerations in this regard on the basis of a review of SUP regulations, waste management scenarios in sub-Saharan Africa and South Asia, and assessment of economic and market potential for SUP substitute materials in the three countries.

8.2.1. Adopt a holistic approach towards SUP regulation based on best practices

A review of regulations that address SUPs in sub-Saharan Africa and South Asia reveals a patchwork of policies and policy instruments. Most countries have resorted to outright bans; while others have also adopted market-based instruments such as taxes. The scope of regulation also varies. Some countries target only plastic bags whereas others cover all types of SUPs. Certain countries have introduced EPR schemes for companies or have regulations on the proper labelling of plastics and of biodegradable or compostable bags and other products. In some countries regulations or bans extend nationwide, whereas in others they are limited to major cities or vary between regions.

It could be useful for policymakers to review and better design SUP regulations from a holistic perspective. Such a review should cover various aspects along the value chain of both SUPs and their non-plastic substitutes. It should ideally result in the adoption of a comprehensive set of policies and national plans adapted to local needs that intervene along critical stages of the life cycle from production to consumption and sale as well as final disposal. Countries could draw upon best practices such as the comprehensive set of policies and regulations adopted by Maldives to address SUPs. These include elements such as restrictions on domestic production, sale and import; the use of market-based instruments; waste data collection; the setting of SUP collection and reduction targets; the establishment of EPR; provision of sustainable alternatives; and giving such products policy support through zero import duties and international standard specifications (such as those set by the ISO), as well as business facilitation, education and awareness programmes. Clear labelling rules and guidelines for plastic substitutes could also be introduced – e.g. guarantees that a product is fully home compostable and contains no plastic contaminants or other harmful additives. EPR schemes also should not only take account of existing packaging issues but also refer to biodegradable alternatives, their production as well as post-use management.

8.2.2. Level the playing field between SUPs and plastic substitutes through market-based instruments and specific regulatory support and incentives for plastic substitutes

A key, and expected, finding from surveys in the case-study countries is the prevalent low price for SUPs compared with the substitutes identified. Extensive government subsidies to the fossil fuel industry in major producing countries enable this situation by artificially lowering plastic feedstock prices. Such subsidies were estimated to be worth at least $5 trillion worldwide in 2017 (Barrowclough and Deere Birkbeck, 2020). This implies that domestic taxes on plastic feedstocks or final SUPs may need to be raised to level the playing field on price as the production of substitutes scales up and market prices for substitutes decline.

In addition, specific consumer incentives can also be explored, particularly schemes that encourage return (e.g. deposit refunds) and reuse where possible. Taxes and import duties that increase the price of raw materials used in manufacturing plastic substitutes could be removed or rationalized – e.g. the 61 per cent tax payable by manufacturers of paper cups in Bangladesh (Parvez, 2017). Such taxes may help raise needed resources to enable the development and expansion of waste management systems in developing countries.

Although there are some examples of clear regulatory support for plastic substitutes, such as the mandate in Bangladesh to use jute for packaging various types of food grains and condiments, regulatory support for substitutes is generally missing in policies that aim to address SUP pollution. Governments could consider including such regulatory support and incentives. Instead of selecting or mandating specific substitutes, it may be better to specify criteria for materials in objective terms such as reusable, fully compostable or made from natural materials. This will enable the market to decide on the best substitute to deploy for specific end-use cases.

Supportive initiatives

Launch global initiatives to address fossil fuel subsidies as well as subsidies granted to producers of plastic feedstock: The WTO could be one possible forum if members agree to launch negotiations along the lines of fishery subsidies. However, such negotiations will almost certainly be time-consuming and not easy to negotiate. Unilateral subsidy reduction measures by major plastic feedstock producing countries could represent another, more feasible option.

8.2.3. Explore regional approaches to address SUPs

Bangladesh, Kenya and Nigeria have ratified a number of international and regional conventions related to plastic pollution (see annex V tables in the SMEP Trade and Pollution Dashboard under Reports, at http://bit.ly/SMEP_UNCTAD. There is no coordinated regional approach to address SUPs specifically in a harmonized manner, except for the East African Community Polythene Materials Control Bill 2016, which is reflected in the laws of EAC member states, including Kenya. Countries that are members of a free trade agreement, single market or customs union could consider adopting a similar harmonized approach that prevents competitive use of SUPs by members and leakage across borders. Trade in many plastic categories is already duty free between members of various regional trade agreements all over the world. As regional integration deepens, for example through implementation of the AfCFTA, adopting a harmonized regional approach towards SUPs could also possibly avoid conflicts between trade and environmental concerns. In addition, the entry into force of the Basel Convention Amendments in 2021 will necessitate some level of regional coordination with regard to plastic waste shipments by members of a regional trading bloc[13].

8.2.4. Introduce policies, regulations and incentives that encourage safer waste disposal and circularity for all material types, and invest in required infrastructure

Lack of infrastructure and monitoring capacity often leads to weak enforcement of SUP laws in many countries in South Asia and sub-Saharan Africa. Even if plastic substitutes are promoted and increasingly deployed, it will be challenging to replace plastics for many end uses. Most developing countries will need additional policies and regulatory frameworks to encourage a circular economy and facilitate sound waste management practices, such as waste segregation and greater recycling for plastics and plastic substitutes (where feasible). More investments are also needed to expand infrastructure, such as recycling facilities, industrial composting facilities and sanitary landfills (for waste that cannot be recycled). Where feasible, systems could be introduced that encourage return and reuse involving, for example, cloth bags, glass and aluminium products, and single-polymer recyclable plastics. This will enhance the sustainability of these materials. It has been difficult in this study to identify suitable substitutes for water sachets, which are a particularly problematic source of pollution in Nigeria. In such cases, governments may wish to promote water-dispensing systems involving the use of refillable and reusable containers, as in Maldives, and extend facilitation and support to businesses that wish to set up refill-and-reused systems; however, the quality of the water supply would also need to be ensured.

In countries where volumes of recyclable waste are limited and setting up national recycling facilities is thus uncompetitive, the possibility of establishing regional recycling facilities using domestic and imported recyclable waste and scrap could be considered. This could lead to greater opportunities for trade in recyclable plastic and non-plastic scrap and waste such as paper, glass and aluminium. Regarding plastics, initiatives at the international level to reduce the use of mixed polymers (that are not conducive to recycling) and move towards using a limited number of fully recyclable polymer streams could also contribute to a reduction in plastic waste. This could be an important consideration for inclusion as part of a possible new United Nations global treaty on plastics, for which momentum has been building (Hogue, 2021; Deere Birkbeck and Sugathan, 2021).

As observed by Barrowclough and Vivas Eugui (2021, p. 12), "Improving waste management is not an easy task as usually the competence falls at the municipal level and it is implemented by direct provision of urban public services, procurement of services or concessions. In many cases, there are not even national policies or enough coordination to introduce incentives to attract recycling or waste treatment private sector participation and investment or to improve economies of scale". Targeted assistance will be needed to bridge these gaps and address investment-related challenges.

Supportive initiatives

Facilitate bilateral and multilateral donor support for investment in infrastructure related to a circular economy: Bilateral donors and multilateral organizations such as the World Bank could assist with respect to investment in infrastructure facilities for environmentally sound waste management facilities that comply with the Basel Amendment requirements. They should also provide support for developing countries to create infrastructure facilities relevant to the circular economy, such as modern recycling plants, in cases where private sector investment may not be immediately possible or feasible. Investment could also be considered in expanding sanitary landfills and industrial composting facilities (that can handle compostable plastic substitute products at scale).

8.3. Harnessing trade opportunities

The analysis of trade flows reveals that SMEP target countries, including Bangladesh, Kenya and Nigeria, are net importers for a large number of substitute feedstocks. As illustrated in Annex Table A6.1, only in specific cases such as jute in Bangladesh and sisal and coconut husks in Kenya, are net exports observed with a proven RCA. However, the situation can vary for end-use products, highlighting the importance of value added manufacturing. For example, although Bangladesh is a net importer of raw cotton, its well-established textile manufacturing industry makes it a net exporter of cotton bags. Hence, imports of certain feedstocks can also make a positive contribution in shifting the economy towards environmentally friendly end-use products. Furthermore, net exports are based on the latest reporting year for trade flow data and the situation could change with time, particularly as SUP regulations become more stringent and nascent feedstock sectors such as vegetable fibres and other agricultural by-products mature. There is also a significant level of South-South trade, including with countries in the same region, for both feedstocks and end-use products. This may increase further as regional integration deepens and applied MFN and preferential duties are lowered or eliminated.

Manufacturing based on certain alternative feedstocks is in the early stages of development in Bangladesh, Kenya and Nigeria. Hence, one strategy may be to focus more on the domestic market rather than exports and build manufacturing capacity. Although emphasis could be laid on tapping into locally available feedstocks and raw materials, countries may wish to establish a strong domestic sector based on imported raw material feedstock. This could also make more economic sense as regional trade integration deepens and manufacturing value-addition develops, particularly in sub-Saharan Africa. In addition, larger regional export markets could provide the necessary demand for end-use products to set up viable manufacturing units at scale. These aspects will need further research for specific countries and raw materials. In summary, policymakers could explore at least four following trade-related options.

8.3.1. Address preferential tariff margin enjoyed by plastic feedstocks over natural substitute feedstocks

In many cases, the import tariff profiles of Bangladesh, Kenya and Nigeria reveal that they apply zero or very low duties, both on an MFN basis and under regional agreements, on plastic feedstocks as compared with many non-plastic feedstocks. This is understandable as countries may wish to procure plastic feedstocks at competitive prices for their domestic plastic product manufacturing industries while sheltering certain natural feedstocks in the country or a customs union from foreign competition. Yet, plastic feedstocks already enjoy a price advantage through fossil fuel subsidies, so they are further advantaged over natural feedstocks by duty-free access in domestic markets. For example, in the Kenya–United Kingdom ECA, Kenya imposes zero duties on imports of plastic feedstocks, but it excludes many natural feedstocks from the scope of the agreement and continues to apply the higher MFN rate of 25 per cent. Although it is challenging to balance the interests of various sectors, countries could explore options to grant duty relief, particularly when import duty concessions could lower the domestic manufacturing costs of plastic substitute products.

8.3.2. Expand the scope of preferential trade access for developing-country exporters of plastic substitute feedstocks and products

Bangladesh, Kenya and Nigeria, and SMEP countries in general benefit from preferential market access to developed-country markets and many developing-country markets through the GSP scheme and various duty-free and quota-free schemes, in the

Supportive initiatives

Revive and strengthen UNCTAD's Global System of Trade Preferences: This tool could provide developing countries with an important vehicle for trade cooperation to extend non-binding preferential tariff treatment to each other, including for non-plastic substitute feedstocks and end-use products (UNCTAD, 2021a).

Pursue multilateral, plurilateral and regional initiatives to liberalize environmental goods: The environmental goods agreement and broader multilateral initiatives pursuant to the Doha negotiating mandate could provide an opportunity to extend market access to developing countries and LDCs on an MFN basis for natural fibres and other plastic substitutes of interest.

case of LDCs. Such preferential access could also be granted by other large developing countries, particularly economies outside Africa for sub-Saharan African countries and outside South Asia for Bangladesh. For example, Brazil, Indonesia and Viet Nam appear among the top five import and export markets for Bangladesh, Kenya and Nigeria, and could consider granting greater access for SMEP countries in South Asia and sub-Saharan Africa for non-plastic feedstocks and end-use products that are fully compostable. In addition, binding any unbound ceiling duty levels could improve the predictability of market access.

8.3.3. Enable developing-country producers and exporters of plastic substitute products to conform to emerging best practices in standards and labelling

There are examples of non-tariff measures that could affect exporters of natural fibre packaging. As exports of plastic substitutes are still nascent, developing-country exporters have not yet faced many challenges related to requirements to comply with standard and labelling schemes specific to such products. This may change in the future, particularly as these standards are adopted as a prerequisite for market access.

The European Commission, in the European Green Deal and new circular economy action plan, has announced a policy framework on the sourcing, labelling and use of bio-based plastics, and the use of biodegradable and compostable plastics.

The European Commission has also announced a framework on the sourcing, labelling and use of biobased plastics, and the use of biodegradable and compostable plastics (European Commission, 2021b). It is too early to assess the implications for the export or use of natural fibre-based packaging in developing countries. The general move within the European Union towards reduced plastic packaging waste could be encouraging for such exports. At the same time, new rules on compostability standards and labelling requirements could pose challenges for developing-country exporters.

Global and regional initiatives that help developing-country exporters comply with new packaging requirements should be a key response strategy. These initiatives could involve international organizations such as UNCTAD, UNIDO, WTO, the International Trade Centre, the World Bank, and bilateral donors.

8.3.4. Further clarify and develop HS classifications relevant to substitutes

Identifying plastic substitutes, particularly end-use products, within the Harmonized System is not easy. Whereas some natural fibre feedstocks such as jute and sisal have their own specific HS code at the six-digit level (the most detailed level at which product codes are harmonized globally), others such as banana and areca leaves are "hidden" within broader six-digit codes that include a large number of vegetable plaiting materials such as bamboo, reeds and rushes. Similarly, although paper and paperboard and products made from paper and paperboard are relatively easy to identify, drinking straws made from wheat fibre are classified under a broader category that includes baskets and other articles made from vegetable materials. This makes it challenging to calculate precisely the global trade flows in these straws.

One of the difficulties in creating distinct HS subheadings that ease the tracking of such trade flows – and also facilitate specifically targeted trade-related duty concessions – is that the World Customs Organization sets a minimum trade volume threshold of $50 million to assign a six-digit subheading and a threshold of $100 million to assign a four-digit heading. However, in previous quinquennial review cycles exceptions have been made for social and environmental reasons[14]. Given the long intervals involved in the review cycles and approval procedures of the World Customs Organization, another option for both exporting and importing countries to consider in the short term may be the creation of specific national tariff lines at a more detailed specification (8, 10 or 12 digits) that can capture these feedstocks and end-use products more precisely, enabling trade statistics to be collected and analysed more precisely.

This report has laid out potential challenges as well as opportunities that many developing countries in general, and Bangladesh, Kenya and Nigeria in particular, face with regard to prospects for replacing some of the most problematic SUP feedstocks and products. It is clear that although trade and trade policy instruments can play a major role in facilitating a transition to environmentally friendlier alternatives, supportive domestic policies and regulations will be required that address the production, sale, consumption and disposal of problematic SUPs as well as incentivize substitutes based on compostable feedstocks that are produced as sustainably as possible. Such policies and regulations should be accompanied by effective enforcement. Furthermore, bilateral and multilateral assistance with regard to technology, training and financing can expand and strengthen domestic manufacturing capacity and enable production at scale. Last but not least, national as well as regional and global governance frameworks that can help level the playing field in terms of competitive pricing between cheap SUP feedstocks and substitutes, including through addressing fossil fuel subsidies, will be critical in laying the foundation for long-term sustainable production and deployment of SUP substitutes.

ENDNOTES

1 UNCTAD's SMEP programme aims to generate cutting-edge scientific evidence that can improve existing knowledge of the environmental health and socioeconomic impacts of selected trade-exposed manufacturing sectors across target countries in sub-Saharan Africa and South Asia. The programme seeks to identify suitable technology-based solutions to address the most pressing environmental health issues associated with manufacturing in target countries and invest in developing business processes and systems that will result in the uptake of pollution control solutions. In addition, the programme addresses the issue of plastic pollution, focusing on identifying and supporting the development of solutions moving towards material substitution and enhanced biodegradation options. See https://unctad.org/project/sustainable-manufacturing-and-environmental-pollution-smep.

2 The three focus countries were selected for this study from the list of candidate SMEP countries on the basis of a number of factors: their contribution to plastic pollution including as major regional manufacturing hubs, their coastal locations, the presence of government initiatives to ban or restrict SUP and private sector initiatives to promote a circular economy, the presence of campaigns by citizens and civil society organizations against plastic pollution and the presence of a well-established manufacturing base with examples of plastic substitutes already being produced.

3 The UNCTAD Oceans Economy and Fisheries Programme seeks to support developing countries in identifying the opportunities and challenges that the oceans economy can bring. It also supports national trade and other competent authorities in designing and creating an enabling policy and regulatory environment that promotes the development and emergence of sustainable oceans economic sectors through the definition and implementation of national and regional oceans economy and trade strategies. See https://unctad.org/topic/trade-and-environment/oceans-economy.

4 The Intergovernmental Panel on Climate Change has estimated a remaining carbon budget for this century of about 800 Gt of carbon dioxide (CO2). This is the amount of emissions that can be emitted until 2100 in order to have a good chance of keeping climate warming below 2°C – and the amount is less for the "well below 2°C" target set by the Paris Agreement. A study by Material Economics (2018) estimates that, if current trends continue, materials production alone would result in more than 900 Gt of emissions. Energy efficiency and use of low-carbon energy will help but do not resolve the dilemma that emissions add up to 650 Gt even with rapid adoption. This is because so much carbon is either built into products and then released at their end of life (plastics) or is inherent to the process chemistry of production (e.g. steel, cement) rather than energy use. For context, 2°C scenarios typically allocate about 300 Gt of CO2 to these production sectors for the world economy (Material Economics, 2018).

5 Dioxins are a group of chemically related compounds that are persistent organic pollutants (POPs). They accumulate in the food chain, mainly in the fatty tissue of animals. Dioxins are mainly by-products of industrial processes but can also result from natural processes, such as volcanic eruptions and forest fires (WHO, 2016). Furans are similar but have a different chemical "skeleton" (Government of Canada, n.d.).

6 In their paper, Babayemi et al. (2019), sometimes uses "plastics" as a general term to cover both polymers (i.e. virgin unprocessed polymeric materials in primary forms) and finished plastic products unless mentioned separately. Plastic components are those embedded in larger products, such as cars and electronics.

7 The beach clean-up resulted in more than 20.8 Mt of trash being collected from beaches in 116 countries in 2019, comprising 32.5 million items picked up in one day (National Geographic Science, 2020).

8 2019 for Nigeria and Kenya and 2015 for Bangladesh.

9 “Variable geometry … means moving in different speed towards the integration. Variable geometry gives states the flexibility to choose the pace of their integration process and a choice to accept or not to accept from different agreements used for implementing the statutory treaty. In addition to the EU, the concept of variable geometry began getting attention in the WTO system and other integration initiatives after the breakdown of the Doha development agenda because of difficulties to reach to consensus between member states of the WTO. Some scholars have argued that variable geometry is a defining feature of African regionalism” Daghne (2019).

10 UNI – the Italian Organization for Standardization – is a private non-profit association recognized by the State and the European Union, that for almost 100 years has been developing and publishing voluntary technical standards in all industrial, commercial and tertiary sectors (see Devex, 2021 and ISO, 2021).

11 Eligible recipients for this programme include businesses and non-governmental organizations investing in plastic-free alternatives (menstrual products, diapers); businesses providing plastic packaging-free goods and services (foods, beauty products, household utilities); businesses providing product service systems, e.g. provision of water as a service by leasing, or renting of water filtration systems; and businesses involved in plastic collection, recycling or exporting.

12 The Basel Convention amendments make it progressively more difficult for the parties to the convention to trade hazardous, contaminated and non-recyclable plastic wastes unless there is prior informed consent from importing countries and these wastes are destined for recycling or disposal that is environmentally sound (United Kingdom Environment Agency, 2020).

13 The Basel Convention amendments make it progressively more difficult for the parties to the convention to trade hazardous, contaminated and non-recyclable plastic wastes unless there is prior informed consent from importing countries and these wastes are destined for recycling or disposal that is environmentally sound (United Kingdom Environment Agency, 2020).

14 For example, the WTO Committee on Market Access (2010) decided to add new text on subheading 0106.12, “to identify separately not only whales and dolphins, but a new group of endangered marine mammals requiring close monitoring (i.e., seals, sea lions and walruses).”

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