सत्यमेव जयते
NITI Aayog

REPORT ON

ALTERNATIVE PRODUCTS and TECHNOLOGIES to PLASTICS and their Applications

MAY 2022

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MESSAGE

Dr. Vijay Kumar Saraswat

Member
National Institution for Transforming India
Government of India

India's per capita generation of plastic waste has almost doubled in the past five years. Nevertheless it remains significantly low in comparison to other countries. However, with rapid urbanization, the plastic consumption has increased and will continue to rise. Hence, it becomes critical to manage plastic waste and find suitable alternatives. Single-use plastic, often referred to as disposable plastic, is commonly used for packaging and includes items intended for use only once before they are thrown away or recycled.

In recent times, another worrisome aspect of plastics is microplastics. As plastics never really decompose, it degrades into smaller particles of up to 5 mm over a long period. The concentration of these particles on land, in air as well as in waterbodies has increased considerably.

Keeping in view of the clarion call made by the Hon'ble Prime Minister on phasing out single-use plastics by 2022, an expert committee was formed by NITI Aayog to assess the development of research on plastic alternatives or technologies making plastic biodegradable and regulatory approaches being taken up globally. The Committee's report focuses on market readiness, infrastructure needs, and regulatory framework required for adopting these products.

Another highlight of the report is postulating clear definitions of bioplastics, biodegradable plastics, compostable plastics, and oxo-degradable plastics as per the end-of-life solutions, which would help categorize the products littered by end-users and proper labelling by the manufacturers.

The Committee has noted that the informal sector and vulnerable groups significantly contribute to recycling waste. It's time that the sector is formalized and integrated under extended producer responsibility. Enhanced transparency in disclosing waste generation, collection, recycling, or scientific disposal is needed to bring accountability and avoid greenwashing.

I want to thank the Government officials, Scientific experts, Industry associations, Academic institutions, and Member Secretary of the Committee, Shri Avinash Mishra and his team, for contributing their time and knowledge to have put forward tangible solutions to tackle the plastic problem effectively. I hope that this report will serve as a roadmap for sustainability in the country.

Dr. V.K. Saraswat
Member, NITI Aayog

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सत्यमेव जयते

MESSAGE

Mr. Amitabh Kant

Chief Executive Officer
National Institution for Transforming India
Government of India

Plastic is a miracle commodity whose introduction transformed every sphere of human life. While its usage ranges from increasing shelf lives of eatables to medical equipment and auto motives, it also accounts for nearly 25% of all domestic plastic waste, and much of it is thrown away within just a few minutes of its first use. The excessive use and exponential rise in the production of plastic has taken a form of environmental misfortune at global level.

Single-use plastics have emerged as a severe environmental threat as they get into water bodies and are carried to oceans and seas, adversely impacting the health of marine ecosystems and the environment. These eventually break down after centuries to form microplastics which have made their way from food chains into human body. While behavioural change is one of the most important and effective tools to avoid the usage of single-use plastics, innovation in finding alternatives to plastic or making plastics biodegradable is equally critical, which will add immensely to the global economy.

The country leapfrogged in its commitment to beat this rising pollution when the Hon'ble Prime Minister pledged to phase out single-use plastics by 2022 on Independence Day in 2019. MoEF&CC notified the Plastic Waste Management rules in August 2021, prohibiting identified single-use plastic items with low utility and high littering potential by July 2022.

The expert committee under the Chairmanship of Dr V.K. Saraswat studied the matter in detail to assess the development of alternatives such as biodegradable and compostable plastics. The alternative product end-of-life solutions show that action can be effortless and profitable with huge gains for people and the planet that helps avert the expensive downstream costs of pollution.

I appreciate all the Committee Members and compliment the efforts of Shri Avinash Mishra, Adviser (NRE) and his team for drafting this report and for their constant efforts and desire to create a cleaner and more responsible India.

Amitabh Kant
CEO, NITI Aayog

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Abbreviations

ABS	Acrylonitrile Butadiene Styrene
BHET	Bis(hydroxyethylene) Terephthalate
BIS	Bureau of Indian Standards
CAGR	Compounded Annual Growth Rate
CIPET	Central Institute of Petrochemicals Engineering & Technology
CO	Castor Oil
CoE SusPol	Centre of Excellence for Sustainable Polymers
CPCB	Central Pollution Control Board
CSIR-NIIST	Council for Scientific and Industrial Research–National Institute for Interdisciplinary Science and Technology
DCPC	Department of Chemicals and Petrochemicals
DEG	Diethylene Glycol
DES	Deep Eutectic Solvent
DRDO	Defence Research and Development Organisation
EG	Ethylene Glycol
EPR	Extended Producer Responsibility
EU	European Union
FICCI	Federation of Indian Chamber of Commerce and Industry
FY	Financial Year
GHG	Greenhouse gas
GoI	Government of India
GST	Goods and Services Tax
HCCBPL	Hindustan Coca-Cola Beverages Private Limited

HDPE	High-Density Polyethylene
HDPs	Host Defence Peptides
HEIs	Higher Education Institutions
HIPS	High-Impact Polystyrene
IISc	Indian Institute of Science
IPIRTI	Indian Plywood Industries Research & Training Institute
IRC	Indian Road Congress
IS	Indian Standards
ISO	International Organization for Standardization
KTPA	Kilo Tons Per Annum
MEG	Monoethylene Glycol
MoEF&CC	Ministry of Environment, Forests and Climate Change
MPW	Mismanaged Plastic Waste
MT	Million Tons
NCRMI	National Coir Research and Management Institute
NGOs	Non-Governmental Organizations
PA	Polyamide
PBAT	Polybutyrate Adipate Terephthalate
PBS	Polybutylene Succinate
PC	Polycarbonate
PCC	Pollution Control Committee
PCL	Polycaprolactone
PE	Polyethylene
PEF	Polyethylene Furanoate
PEG	Polyethylene Glycol
PET	Polyethylene Terephthalate
PG	Propylene Glycol
PHAs	Polyhydroxyalkanoates
PIBO	Producers, Importers, and Brand Owners
PLA	Polylactic acid
PP	Polypropylene
PS	Polystyrene

PSF	Polyester Staple Fibre
PUs	Poylurethanes
PVA	Polyvinyl Alcohol
PVC	Polyvinyl Chloride
PWM	Plastic Waste Management
PWPs	Plastic Waste Processors
RE&CE	Resource Efficiency and Circular Economy
ROP	Ring-Opening Polymerization
SAP	Systems, Applications, and Products in Data Processing
SERB	Science & Engineering Research Board
SOP	Standard Operating Procedure
SPCB	State Pollution Control Board
SRC	Semi-Refined-κ-Carrageenan
SUP	Single-Use Plastic
TPA	Terephthalic Acid
TRL	Technology Readiness Level
UN	United Nations
UNDP	United Nations Development Programme
USA	United States of America
WtE	Waste to Energy

Chapter
1

Executive Summary

Plastic is the classic example of a boon turned bane in society. Once proved to be a miracle, plastic has become a peril to nature in several terms that affect marine life to land resources. Plastics have outgrown most manufactured materials and have long been under environmental scrutiny. However, despite several technological advancements, the end-of-life of plastic is still lacking. Between 1950 – 2015, the cumulative production of polymers, synthetic fibre and additives was 8300 million tons, of which 4600 million tons (55 per cent) went straight to landfills or were discarded, 700 million tons (8 per cent) incinerated, and only 500 million tons (6 per cent) was recycled. By 2050, as per current production and waste management trends, had it continued at the same rate, it would have generated 12,000 MT[1].

12,000 MT Plastic Waste = One Billion Elephants

Single-use plastics (SUP), often referred to as disposable plastics, are commonly used for plastic packaging and include items intended to be used only once before being thrown away or recycled. They are non-biodegradable and harm our health, wildlife, and the environment. They take years to disintegrate and further break down into smaller pieces of plastics known as microplastics contaminating food and water, including oceans.

Therefore, for a developing country like India, that can ill afford these risks and contaminations to food and water sources, it is necessary to design and implement effective legislation that regulates plastics waste on the hand and encourages alternatives to plastics on the other.

Keeping in view the adverse impacts of littered plastic on terrestrial and aquatic ecosystems, in 2019, Prime Minister Shri Narendra Modi issued a call to phase out SUP by 2022. Subsequently, the government has adopted a three-pronged approach in tacking this problem, viz. behavioural change, institutional mechanisms, and extended producer responsibility. The Government of India (GoI) has considered and enacted a range of environmental legislation governing plastics, particularly on the

1 https://www.wired.co.uk/article/global-total-plastic-waste-oceans

end-of-life management and mitigation of plastic waste pollution. The policy push toward resource efficiency, circular economy opportunities in plastics, and an emphasis on recycled plastics have also been key focus areas.

The extent to which plastics can get recycled depends on a range of technical, economic, logistical, and even sociocultural factors. Virgin plastic material can be recycled only 2-3 times only because after every recycling, the plastic material deteriorates due to thermal pressure, and its life span is reduced. Hence recycling, while useful is not the only approach that will address this issue. Material innovation presents a large opportunity as well: A wide variety of natural materials are utilized to meet society's needs. Plant fibres for textiles are dominated by cotton, followed by jute, and related plants and textiles have seen significant sustainable innovation in recent years. Similarly, other approaches to manage plastics waste should include biodegradable plastics and compostable plastics.

Some of these are early stage but hold significant promise. Bioplastic production all over the world is still minimal when compared to conventional plastics and they are also 1.5-4 times more expensive than their fossil-based counterpart and will require significant technology investment and scale to drive down unit costs. Similarly, there are emerging technologies that have developed additives to make completely biodegradable polyolefins, such as polypropylene (PP) and polyethylene (PE). These biodegradable plastics are developing as a potential alternative to conventional plastics. At present, both aerobic as well as anaerobic biodegradable plastics are available and over 150 compostable plastic manufacturers have been certified by the Central Pollution Control Board. They manufacture a wide range of products, including films, bags, cutlery items, straws, gloves, aprons, thermoformed products etc.

While environmentally friendly biodegradable plastics are a desirable solution, it is essential that they also fulfil required functional performance parameters (i.e. moisture barrier, heat sealability, etc.) for them to see widescale adoption. Such scaling up from the lab to commercial processes will be vital to achieve cost reduction and widespread adoption. There is an urgent need to upgrade the infrastructure of government and private testing laboratories so that they are well equipped to test plastics according to Indian Standards (IS) as mentioned in Schedule I of PWM Rules. The manufacturers should also be encouraged through appropriate measures to shift from conventional plastics to biodegradable plastics across categories.

Chapter
2

Introduction

Plastic derives its name from the Greek term *plastikos* which means capable of being shaped or moulded. It has replaced a broad range of traditional materials and found innumerous applications ranging from everyday single-use products such as packaging and bottles to long-lasting furniture, clothes, automotive components, and building materials.

Plastics are obtained when monomers that can be synthetic or semi-synthetic organic (carbon-containing) compounds, mainly derived from natural gas and crude oil, are blended with inorganic compounds in a catalyst at defined parameters. Further, additives are added to make the plastics heavy and durable, termed thermoset (e.g. sheet moulding compound (SMC), fibre reinforced plastic (FRP). As a whole plastics weigh less, cost less, and offer outstanding technical properties[2] compared to alternatives.

Additives like plasticizers make plastic more flexible, called thermoplastic (e.g. PET, LDPE, HDPE, PVC, etc.). However, these additives damage both the environment and human health when they enter our water and food systems and when they get released into the environment while recycling. Thermoplastics constitute 94% of the total plastic waste generated and are recyclable, whereas the thermosets are non-recyclable[3].

In India, the plastics industry symbolizes a promising business segment that creates income and employment opportunities for both skilled and semi-skilled persons and contributes to the 'Make in India' initiative. Packaging materials account for 24% of the total domestic consumption of plastic, followed by agriculture at 23%, and household items at 10%. Data from the packaging segment data reveals that PE and PP account for around 33% and 29% of polymer usage respectively, followed by polyethylene terephthalate (PET) at 17%, polyvinyl chloride (PVC) at 7%, and others at 14% in this segment[4]. Finished plastic products also constitute a significant component of value-added product exports.

2 d'Ambrières, W., 2019. Plastics recycling worldwide: current overview and desirable changes. Field Actions Science Reports. The Journal of Field Actions, (Special Issue 19), pp.12-21

3 https://cpcb.nic.in/uploads/plasticwaste/LCA_Report_15.05.2018.pdf

4 https://chemicals.nic.in/sites/default/files/SUP_Expert_Committee_Report.pdf

2.1 THE PLASTICS PROBLEM IN INDIA

India's plastic consumption has been growing significantly and despite per capita usage levels lower than most other developing and developed countries, plastic pollution has emerged as one of the significant problems in the country.

Plastics have become an integral part of society and we have come to rely on them in all spheres of life. Researchers have estimated that more than 8300 million tons of plastics have been produced since 1950[5]. Historically, plastics were predominantly made from petrochemical products and this dependence continues. Presently, ~4% of fossil fuel extracted annually ends up being used as raw materials for plastics production. Technically, it is the natural gas liquid fraction or low-value gaseous fraction from petroleum refining that is mainly used to make plastics[6].

India produced approximately 3.47 million tons of plastics waste per annum, as per the Central Pollution Control Board (CPCB) report[7] with the per capita waste growing from 700 gms to 2500 gms over the last five years. Unfortunately, only a small amount of this plastic waste gets recycled. A majority of this waste leaks into the environment through various polluting pathways. India collects only 60% of its plastic waste with the remaining 40% remaining uncollected and enters the environment directly as waste. These numbers are relatively small compared to developed nations but these trends are not sustainable given simply the volume of plastics in India. Alternatives to plastics will play a significant role going forward.

The Hon'ble Prime Minister, Shri Narendra Modi, in his 2019 Independence Day speech, announced the goal the phasing out of SUP by 2022. Since then, the Ministry of Environment, Forest and Climate Change, Government of India, has notified the Plastic Waste Management (PWM) Amendment Rules, 2021, which prohibit specified SUP items that have low utility and high littering potential by July 1, 2022. However, SUP is not confined to the plastic manufacturing or processing sector alone. A range of manufacturing and services sectors such as agriculture, public health, medical equipment, food services, etc., are all critically dependent on SUP. Thus, a well-designed and systematic strategy is needed to combat the SUP problem otherwise there is a risk of exacerbating the problem. In addition to policy and regulation, it will be critical to ensure that these policies and regulations get implemented and best practices aligned to the 5Rs (redesign, reduce, reuse, recover, recycle) of a circular economy approach to plastics get adopted at national scale.

In view of this, NITI Aayog, under the Chairmanship of Hon'ble Member Dr V.K. Saraswat, set up a committee to identify alternatives to plastics as well as technologies that make plastics biodegradable. The committee also assessed infrastructure needs, market readiness, and appropriate regulatory and policy approaches to facilitate the transition to plastic alternatives and sustainable plastics. The relative advantages and disadvantages of substitution, conversion technologies, and necessary procedures were carefully considered while developing alternatives.

5 UNEP. Our planet is drowning in plastic pollution—it's time for change! https://www.unep.org/interactive/beat-plastic-pollution

6 Lebreton L., and Andrady A. Future scenarios of global plastic waste generation and disposal. Palgrave Commun. 2019, 5, 6. https://doi.org/10.1057/s41599-018-0212-7

7 Management Rules, 2016. https://cpcb.nic.in/uploads/plasticwaste/Annual_Report_2019-20_PWM.pdf

SWOC Analysis

Strengths

- Improved human health and environment
- Waste minimization
- Wider applications

Weakness

- Confusion in classification of the type of plastic
- Lack of infrastructure and policy support
- Not completely carbon neutal

Opportunities

- Development of novel applications where there are no equivalent non-plastic alternatives

Challenges

- Unit cost
- Scalability of domestic R&D
- Social and economic impact due to transition to biodegradable plastics

2.2 TERMS OF REFERENCE

The terms of reference of the committee were as follows:

1. To assess the status of the development of bio-degradable plastics and materials globally
2. To assess the directions of research and development being carried by global majors involved in plastics
3. Understand the status of domestic R&D by public and private polymer manufacturers, R&D institutions/strategies to catalyze the research and development of bio-degradable plastics and the role of public-funded R&D projects in this domain.
4. To identify research in bio-degradable polymers that needs to be carried out to meet the requirements of the automobile industry, the agriculture sector and other industrial applications
5. To understand how the scaleup of R&D activity, the translation of R&D into commercialization uses, and production could be funded by the industry and what roles would the government and the private sector need to take for large scale commercialization of plastics alternatives and biodegradable plastics
6. To identify how industry partners would facilitate and would be responsible for the identification of different products and the application thereof for R&D teams to conduct research accordingly
7. To determine how the committee would need to approve project proposals, monitor progress and coordinate commercialization with the industry
8. To assess how finances for the research programme would be borne by the Department of Science and Technology.
9. To asses how major R&D projects could be supported by the Government of India or jointly by the Government of India and Industry.

Chapter
3

Assessment of Global and Indian plastic production and usage

3.1 GLOBAL TRENDS

Since their invention, plastics have transformed the way we live and have become omnipresent in our lives: be it clothing, transportation, communication, health care, manufacturing equipment, money, or almost any other sphere of life. Deemed a miracle material, plastics helped free people from socio-economic constraints imposed by scarce natural resources. No wonder plastics were called the materials of the 21st century.

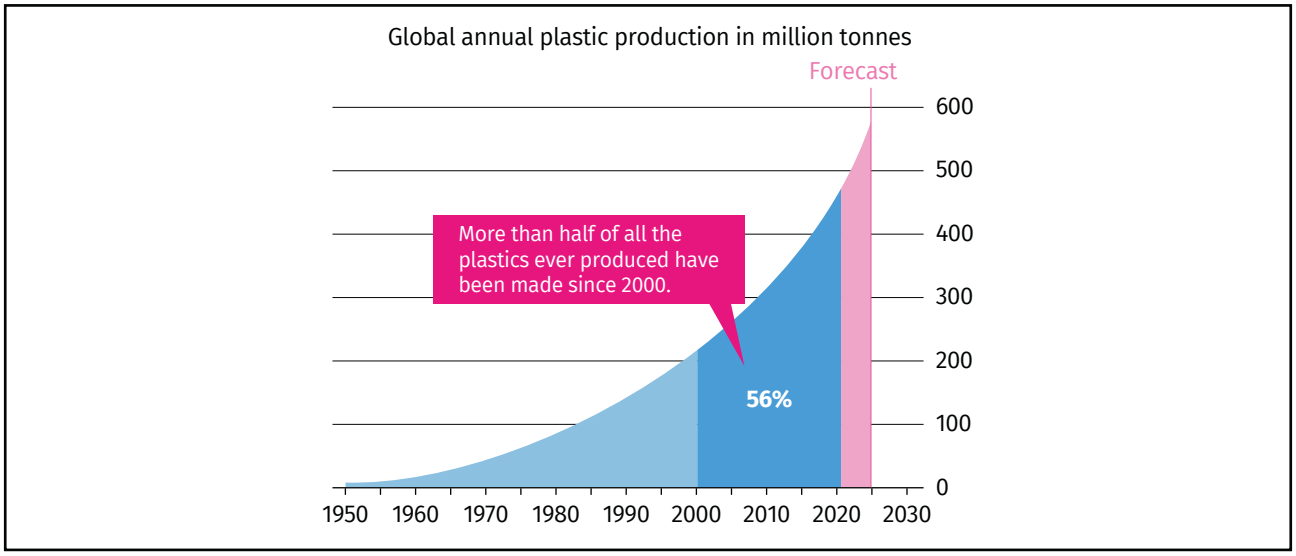


Figure 1: *Global production of plastics in million tons*

Source: *Plastic Atlas 2019 | Plastic soup foundation*

Globally, 97-99% of these plastics are derived from fossil fuel feedstock while the remaining 1-3% come from bio (plant) based plastics[8]. The amount of plastic that is produced in the world every year has increased exponentially in just a human lifetime, i.e. from 2 million tons in 1950 to 381 million tons in 2015[9]. production. The global per capita consumption (2014-15) was 28 kgs.

8 https://gridarendal-website-live.s3.amazonaws.com/production/documents/:s_document/554/original/UNEP-CHW-PWPWG.1-INF-4.English.pdf?1594295332

9 https://www.science.org/doi/10.1126/sciadv.1700782

More than half the total amount of plastic produced was only brought to market after 2000. The expectation is that production will further increase to about 600 million tons in 2025 (Figure 1). This is roughly twice the total weight of the world's population today[10]! The packaging industry dominates the consumption by about 42%, followed by the building and construction sector utilizing 19% of the total plastic created.

Many SUP products such as face masks, medical equipment, shopping bags, coffee cups, and cling film are everyday "essentials" in our lives adding tremendous value. The production of SUP has doubled since 2005 alone and is expected to increase by a further third between 2020 and 2025. Today, they are the most common type of plastic produced, consuming over a third of all polymers, the building blocks of plastics made every year. China is the largest producer of SUP, followed by the US and India.

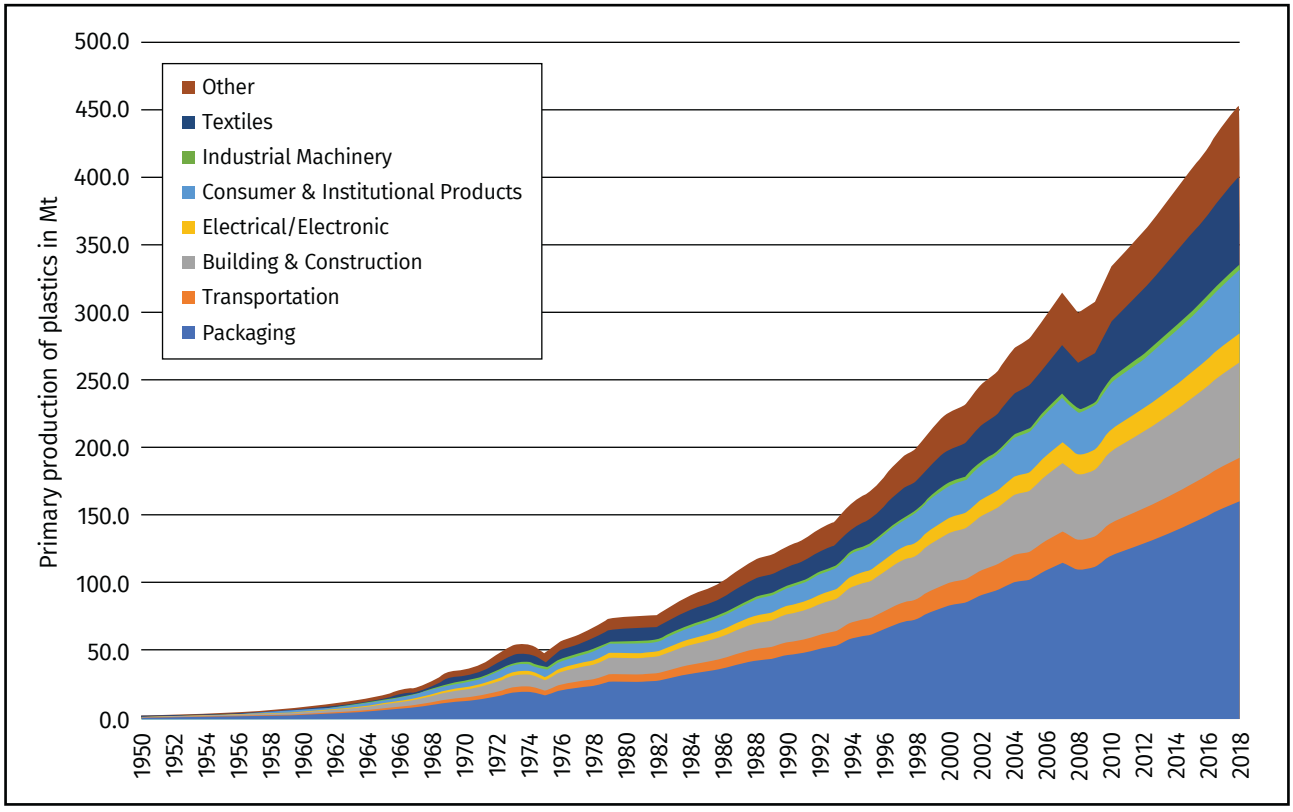


Figure 2: *Global primary and global plastic production (in million tons) according to type between 1950-2018 (Geyer, 2020)*

10 https://www.plasticsoupfoundation.org/en/plastic-facts-and-figures/

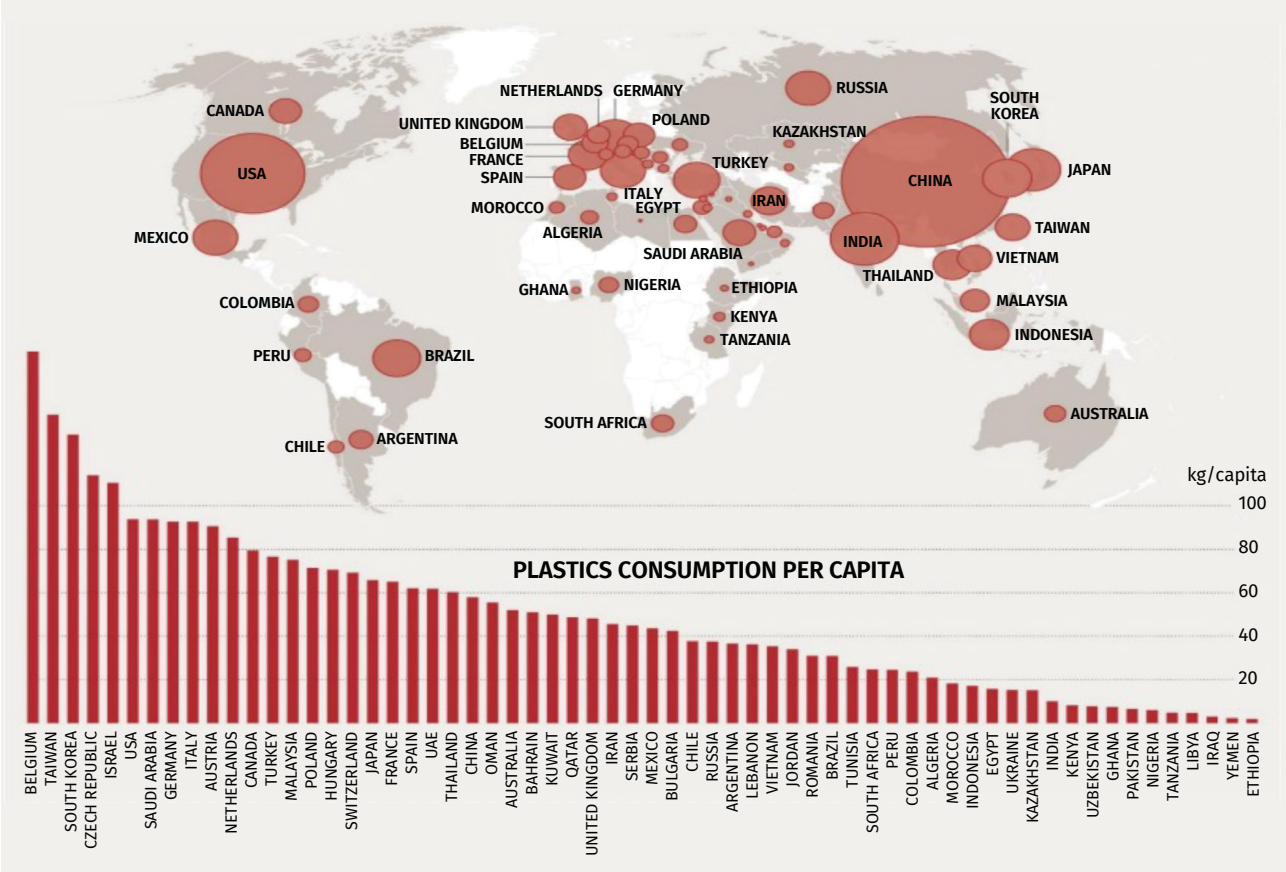


Figure 3: *Plastic consumption by country (kg/capita)*

Source: *UNEP Baseline report on plastic waste*

China is among the most prominent plastic consumers accounting for 20% of the global plastic consumption and is followed by Western Europe, which accounts for 18% of the worldwide plastic consumption and then United States of America (USA). However, in terms of plastic consumption per capita, China is ranked much lower than other countries. On the contrary, the European Union (EU) is one of the largest per capita consumers of plastic (Figure 3).

3.2 INDIAN TRENDS

The Indian plastics industry started in 1945 and has been growing over the years. From 0.9 million tons in 1990 to 18.45 million tons in 2018, plastic consumption has grown 20 times since then[11].

The plastics industry is one of the biggest generators of employment in the country, valued to be around INR 5.1 lakh crore (USD 73 billion). Owing to near universal use of plastics in wide range of sectors, the plastics industry is one of the fastest growing in India.

There are over 30,000 units that produce plastic materials in India. Approximately 90% of these units are small and medium-sized enterprises. The Plastic industry employs about 4 million people. In Financial Year (FY) 20 (till January 2020), plastic exports stood at USD 7.045 billion, with the highest contribution from plastic raw materials at USD 2.91 billion; plastic sheets, films, and plates at USD 1.22 billion; and packaging materials at USD 722.47 million[12].

11 https://www.plastindia.org/plastic-industry-status-report.php

12 https://www.ibef.org/exports/plastic-industry-india.aspx

From a demand-side perspective, packaging shares 24% of total domestic consumption, followed by agriculture (23%), household items (including home furnishings: 10%) (Figure 4).

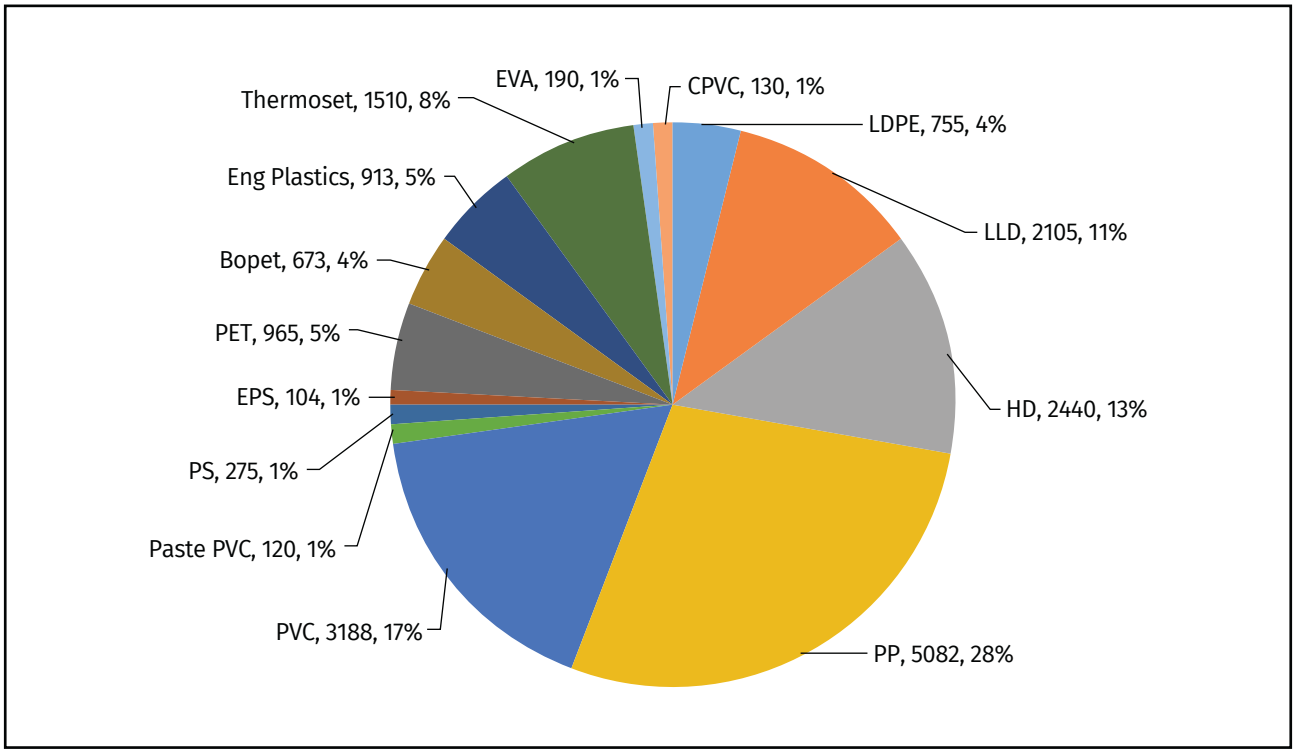


Figure 4: *India's plastic consumption (2018-19) in KT*

Source: *India Plastics Industry Report 2019, PlastIndia Foundation*

Environmental impacts of plastics including microplastics on land, marine ecosystems, and climate change

Chapter 4

Some plastic products such as building and construction materials (35 years), industrial machinery (20 years), plastic products in the transportation sector (13 years), electrical/electronic plastic products (8 years), and textiles (5 years) have long life spans. However, a majority of plastic products encountered every day have a short life cycle lasting between one day (e.g., disposable plastic cups, plates, takeaway containers, plastic bags, etc.) to three years (e.g., food and drink containers, cosmetics, agricultural film, etc.)[13]. None of these commonly used plastics is biodegradable.

4.1 GLOBAL PLASTICS WASTE PATTERNS

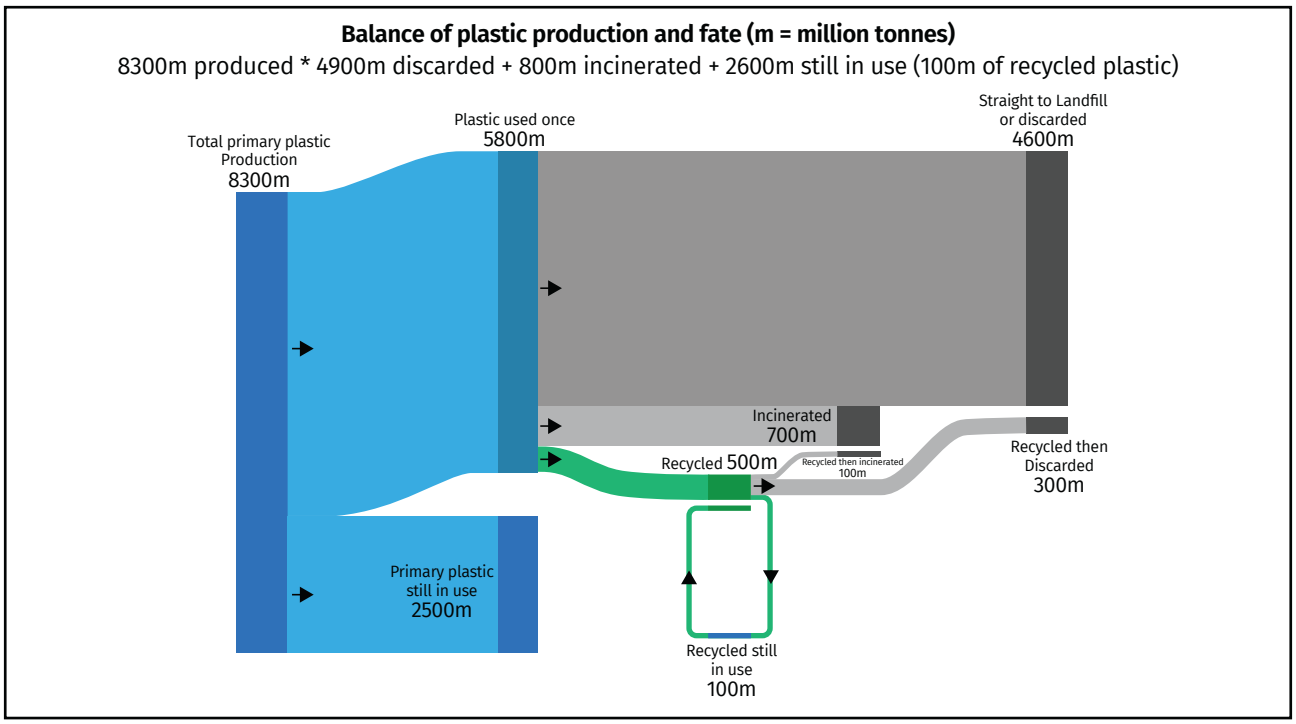


Figure 5: *Global plastic production and disposal method (1950-2015) in million tons*

Source: *based on Geyer et al. (2017). Production, use, and fate of all plastics ever made.*
This is a visualization from OurWorldinData.org, where you find data and research on how the world is changing. Licensed under CC-BY-SA by Hannah Ritchie and Max Roser (2018).

13 https://ourworldindata.org/grapher/mean-product-lifetime-plastic

Most global plastics waste is generated in Asia but the US, the EU, and Japan lead in terms of per capita plastic packaging waste.

Between 1950 – 2015, the cumulative production of polymers, synthetic fibres and additives was 8300 million tons, of which 4600 million tons (55 per cent) went straight to landfills or were discarded, 700 million tons were incinerated (Figure 5).

Plastic overconsumption and mismanagement is a growing menace across the globe and is leading to overflowing landfills, blocked rivers, and threatened marine ecosystems. This has a negative impact on sectors that are critical to many economies, including tourism, shipping, and fisheries[14]. There are the hundreds of thousands of landfills, drains and rivers choked with plastic waste, especially in the developing world.

The production and disposal of plastics are also responsible for significant greenhouse gas emissions. In addition, the loss of natural resources resulting from current waste management systems represents a missed economic opportunity. For example, estimates suggest that 95% of the material value of used plastic packaging, or USD 80–120 billion, is lost annually[15].

As per the 2018 UNEP report, plastic litter in the Asia-Pacific region alone costs its tourism, fishing, and shipping industries USD 1.3 billion per year. In Europe, cleaning plastic waste from coasts and beaches costs about €630 million per year. Studies suggest that the total economic damage to the world's marine ecosystems caused by plastic amounts to at least USD 13 billion every year. Thus, the economic, health and environmental reasons to act are clear.

According to the Plastic Waste Makers Index 2021, Singapore tops the list of the countries in per capita SUP waste generation at 76 kg followed by Australia at 56 kg. The report also states that in absolute terms China (25.36 MT) is the largest producer of SUP followed by the US (17.19 MT) and India (5.58 MT). Japan closely follows India with 4.7 MT of annual plastic waste.

Lately, another worrying aspect of plastics, microplastics, has been gaining attention. Plastics can deteriorate and fragment into minute particles when exposed to ultra-violet sunlight, water, and salts. They can be ingested by simple life forms and enter the food chain. Their pervasive dominance means that they are now embedded in, quite literally, every habitat in the world, even in the most isolated ecosystems. One sample of microplastics found in the Arctic snow amounted to more than 10,000 of them per litre of melted snow.

4.2 TRENDS IN INDIA

Approximately 3.4 million tons per annum of plastic waste was generated in India in 2019-20 while the per capita waste generation trend for the last five years (2016-20) has almost doubled over the previous five years (Figure 6).

Goa, Delhi & Kerala have reported the highest per capita plastic waste generation, while Nagaland, Sikkim and Tripura have reported the lowest per capita plastic waste generation.

14 https://blogs.worldbank.org/eastasiapacific/plastic-waste-growing-menace-and-wasted-opportunity

15 https://www.oecd.org/environment/waste/policy-highlights-improving-plastics-management.pdf

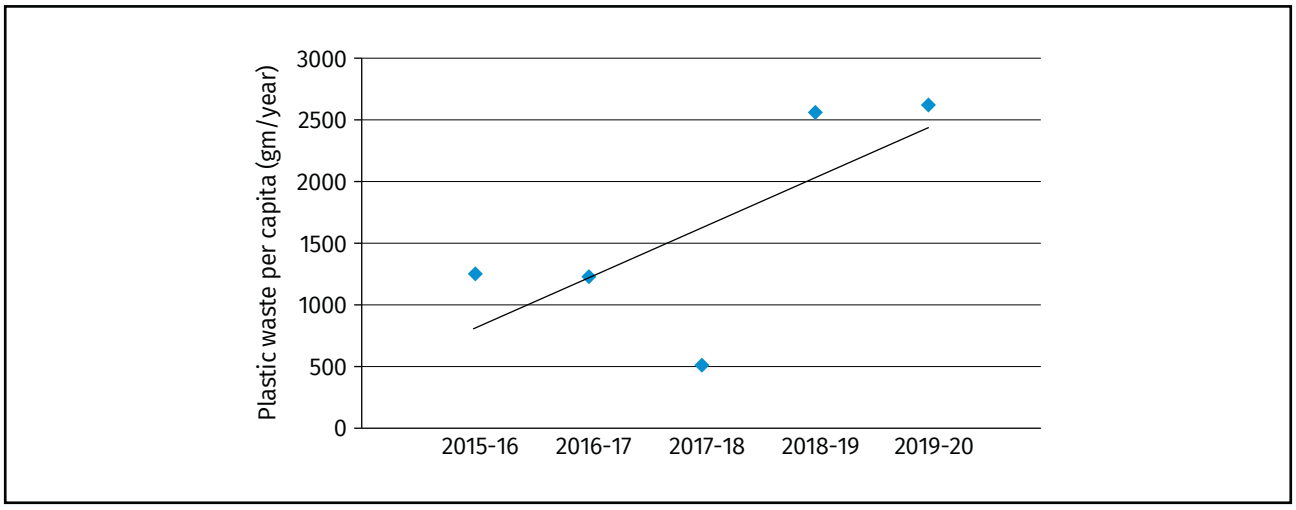


Figure 6: *Per capita plastic waste generation*

Source: *CPCB Annual Report 2019-20*

The waste management infrastructure in the States/UTs was strengthened through the Swachh Bharat Mission and presently, a portion of the plastic waste generated by States/UTs is utilized for different purposes such as recycling, road construction, waste to energy plants, waste to oil plants, and cement plants for co-processing. However, texact quantities of plastic waste utilized for these has not provided by most of the states/UTs[16].

4.3 PLASTIC AND CLIMATE

Nearly every piece of plastic begins as a fossil fuel, and greenhouse gases (GHG) are emitted at each stage of the plastic lifecycle: 1) fossil fuel extraction and transport, 2) plastic refining and manufacture, 3) managing plastic waste, and 4) ongoing effects within oceans, waterways, and various ecosystem landscapes.

As per a recent CIEL report[17], at current levels, greenhouse gas emissions from the plastic lifecycle threaten the ability of the global community to keep global temperature rise below 1.5°C degrees. If plastic production and use grows as currently planned, by 2030, these emissions could reach 1.34 gigatons per year, equivalent to the emissions released by more than 295 new 500-megawatt coal-fired power plants. By 2050, the cumulation of these greenhouse gas emissions from plastic could reach over 56 gigatons, or 10 – 13% per cent of the entire remaining carbon budget.

16 https://cpcb.nic.in/uploads/plasticwaste/Annual_Report_2019-20_PWM.pdf

17 https://www.ciel.org/wp-content/uploads/2019/05/Plastic-and-Climate-FINAL-2019.pdf

Chapter
5

Plastic Waste Management

5.1 RECYCLING OVERVIEW (RECYCLING UNITS, PEOPLE ENGAGED, ECONOMIC CONTRIBUTION)

Globally, between 10-60% of plastic waste gets recycled across different countries; it averages 30% in most countries in the EU and only about 10% in the US. Additionally, in many developed nations, a larger fraction of plastics waste gets thermally treated to recover energy as opposed getting recycled for material recovery. For instance, in Japan, Sweden, and Denmark, thermal treatment covers 56%, 81.7%, and 57.1% of the total plastic waste generated, respectively. However, material recycling of plastics tends to reduce the environmental footprint of plastic use and consumption significantly with astudy estimating that we save approximately 3.8 barrels of petroleum by recycling a tonne of plastic waste, thereby reducing our reliance on fossil fuels[18].

India does better in this aspect due to a large informal sector workforce (comprised of individual waste pickers and waste traders) making a living by collecting, sorting, recycling, and selling valuable plastic materials recovered. Approximately 60% of plastic waste gets collected for recycling and recovery in India, which is much higher than in developed countries.

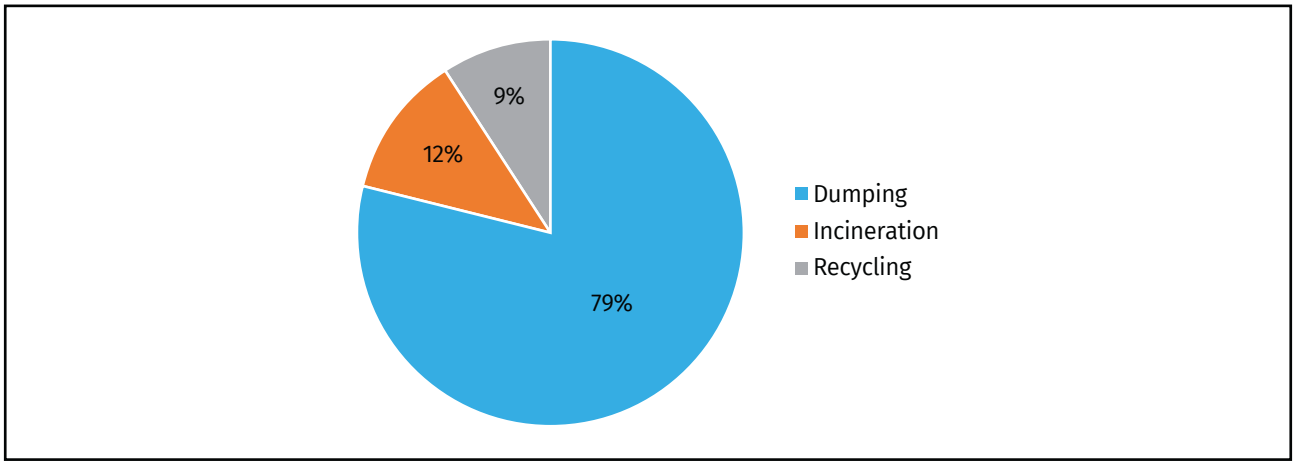


Figure 7: *The fates of plastic waste across the globe*

Source: *Ronald Geyer et al 2017. "Production, use, and fate of all plastics ever made." Science Advances Vol. 3*

18 Oblak, P., Gonzalez-Gutierrez, J., Zupančič, B., Aulova, A. and Emri, I., 2015. Processability and mechanical properties of extensively recycled high density polyethylene. Polymer Degradation and stability, 114, pp.133-145.

The Indian recycling industry relies significantly on the unorganized sector, such as waste pickers and waste collectors, to collect plastics. The collected plastic is further transferred to small aggregators, from where it reaches a medium or large dealer and finally goes to recycling units. Other unorganized players are also involved in unit operations, including shredding, flaking, and washing the plastic. The value of processed plastic increases as plastic waste moves up the value chain.

Value extraction pathways

Recycling and energy recovery from plastics waste can be carried out in three ways[19]:

i. **Mechanical recycling**–This recycling method reprocesses the plastic waste into a secondary plastic material via primary and secondary recycling options. Primary recycling is the preferred technique as it does not require much energy and resources to create operational units as it is free from any contamination. This is followed by secondary recycling, where the unit operations increase significantly due to activities like de-dusting, washing and cleaning. Both primary and secondary recycling are the most prevalent form of recycling in India and constitute 94.17 % of the total plastic waste being recycled. However, derived secondary products through these processes are lower grade or economic value and cannot replace the original commodity or the outcome. Hence, this process of recycling only delays the final disposal of the plastic.

ii. **Chemical or feedstock recycling**–Under this process, tertiary recycling methods are used to convert the plastic waste into oil, gas or its monomeric constituents through chemical conversion, which can further be used as fuel. It is the least preferred method in India with only 0.83% of the plastic waste getting processed due to high capital and operational expenditure as well as the non-availability of scalable technologies in India.

iii. **The third option of quaternary recycling offers two possibilities, viz., energy recovery and alternate use, both of which cannot be considered recycling**. Energy recovery is carried out at 'Waste to Energy' (WtE) plants and incineration facilities or through co-processing in cement kilns. However, these WtE processes applied to plastics waste convert land-based pollution to water and air pollution unless expensive pollution control equipment is in place. Under alternate use, the collected plastic waste is used for a purpose other than for which it was created, such as road-making with plastic waste, which is now a mandate as per the Indian Road Congress (IRC). This is a relatively less preferred method as it has high capital and operational costs, ambiguity around suitability and acceptability of technology, as well as risks of converting land-based pollution to air and water pollution. However, this is still selected over simply dumping or landfilling plastics and contributes to managing 5% of the plastic waste in India. Moreover, an increasing number of businesses and authorities at the local, state and national levels are moving towards this method as it offers fast and interim solutions for plastic waste, which is otherwise non-recyclable or difficult to recycle.

Thus, there is a general hierarchy within plastic recycling based on the degree to which the polymer stays intact, which overlaps with the inner (material remains unchanged) and outer loops (material not intact) of circular economy principles. This is captured in the categorization of primary (most intact), secondary, tertiary and quaternary recycling (least intact). Hence, primary recycling is considered the most optimal (inner loop) and quaternary recycling (outer loop) the least. At this point in time in

19 Indian Plastics Industry Report, PlastIndia foundation, 2019. https://www.plastindia.org/plastic-industry-status-report.php

India, plastic recycling occurs mainly through mechanical recycling from mixed waste streams and is categorized as secondary recycling (open-loop recycling). In this system, the plastic is downcycled, meaning it is only partially re-used for the same purpose due to quality reduction. Some of these quality and quantity recycling gaps are a result of plastic waste being collected in a mixed stream, consisting of different polymers and even materials (metals, cardboard, rubber and more).

Furthermore, plastic products can contain a mix of materials and polymers, including multilayer materials, copolymers, stickers, fillers and additives, which complicate the recycling process. These conditions vary enormously across plastic applications and sector, and hence across waste streams. To summarize, presently, recycling takes place for a limited selection of the total plastic waste streams, with only a few recycling technologies applied on a large scale, while the process itself is complex and suboptimal due to quality limitations. However, there are alternative, innovative recycling technologies that might fill these gaps and surpass the limits and boundaries associated with existing recycling methods from different waste streams (Figure 8). This includes tertiary recycling options where the plastic waste is recycled to monomers or feedstocks with thermochemical methods. Other chemical recycling options are being developed as well, such as depolymerization, which breaks polymer bonds using chemicals, or dissolution with solvents that keep polymers intact. Unfortunately, it is still not fully known which existing or innovative recycling technologies theoretically offer environmental benefits for each plastic application, and hence which technologies would fit best in a circular economy approach to managing plastics waste in India.

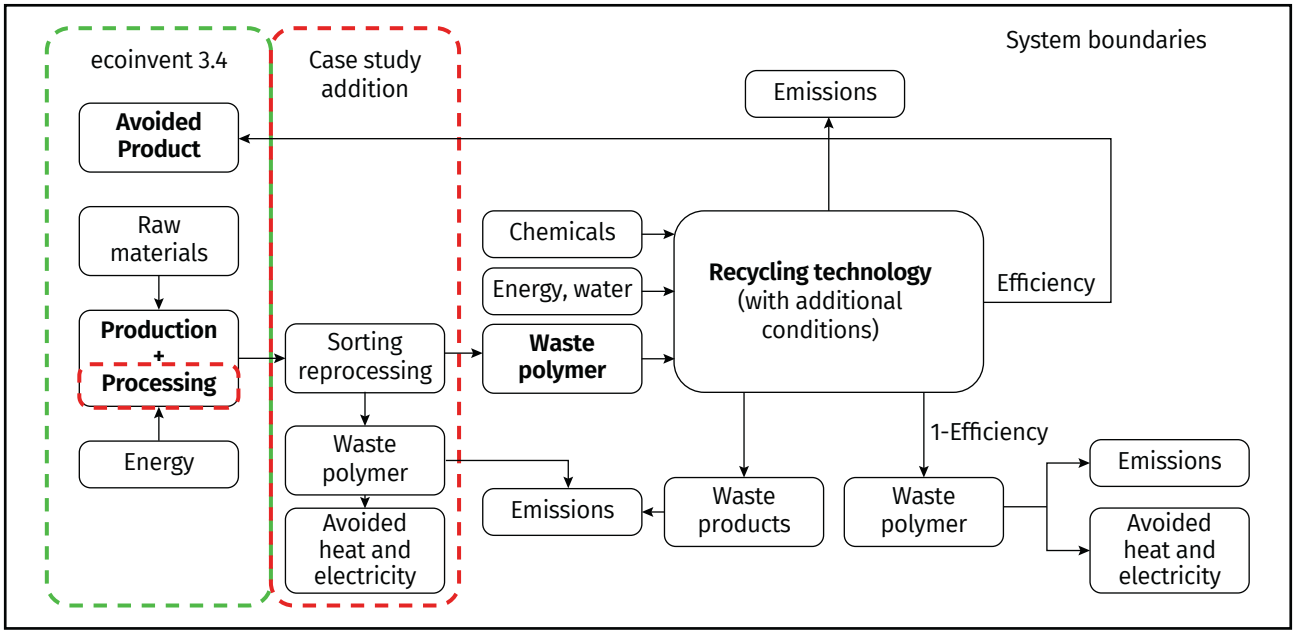


Figure 8: *Alternative system boundaries for using the life cycle analysis matrix model are used within the defined case study frameworks*

In the current scenario, many adverse effects of plastics can be addressed by recycling as it represents one of the most promising areas in the plastics industry today. Recycling provides options to reduce carbon dioxide emissions, oil usage, and the quantities of waste requiring disposal. Life cycle analysis exhibits that it is the most environmentally friendly option with present processing technologies, ranging from processing PP/PE or PET in France or Asia and irrespective of whether the energy performance of current incineration facilities is low or high. The same analysis supports that GHG emissions can be reduced by 20–50% by using recycled plastic instead of raw plastic.

5.2 IMPLEMENTATION STATUS OF EXTENDED PRODUCER RESPONSIBILITY (EPR)

In 1999, the Ministry of Environment and Forests (then MoEF) notified the first-ever law on plastics in the form of The Plastics Manufacture, Sale and Usage Rules. Since then, the country's waste management regulations have evolved significantly.

Plastic Waste (Management and Handling) Rules 2011 were introduced in the country to address the issue of Plastic Waste Management (PWM) under the Environment Protection Act in 1986 by the Ministry of Environment and Forests, Climate Change (MoEF&CC). These were notified in 2016 and amended in 2018, 2021 and 2022. The PWM Rules 2016 stress the minimization of plastic waste, segregation at source, recycling, and implementing the polluters pay principle for the sustainability of the waste management system.

Rule 10 of the PWM Rules specifies that the degree of degradability and degree of disintegration of compostable and biodegradable plastic material shall be as per the protocols of the IS listed in Schedule-I (Figure 9).

1.	IS / ISO 14851: 1999 Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium-Method by measuring the oxygen demand in a closed Respirometer
2.	IS / ISO 14852: 1999 Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium-Method by analysis of evolved carbon dioxide
3.	IS / ISO 14853: 2005 Plastics- Determination of the ultimate anaerobic biodegradation of plastic materials in an aqueous system-Method by measurement of biogas production
4.	IS /ISO 14855-1: 2005 Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions-Method by analysis of evolved carbon dioxide (Part-1 General method)
5.	IS / ISO 14855-2: 2007 Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions-Method by analysis of evolved carbon dioxide (Part-2: Gravimetric measurement of carbon dioxide evolved in a laboratory- scale test)
6.	IS / ISO 15985: 2004 Plastics- Determination of the ultimate anaerobic biodegradation and disintegration under high-solids anaerobic digestion conditions- Methods by analysis of released biogas
7.	IS /ISO 16929: 2002 Plastics- Determination of degree of disintegration of plastic materials under defined composting conditions in a pilot - scale test
8.	IS / ISO 17556: 2003 Plastics- Determination of ultimate aerobic biodegradability in soil by measuring the oxygen demand in a Respirometer or the amount of carbon dioxide evolved
9.	IS / ISO 20200:2004 Plastics- Determination of degree of disintegration of plastic materials under simulated composting conditions in a laboratory - scale test

Figure 9: *Schedule-I of plastic waste management rule*

As the proposed amendment to Rule 10 as per the draft Notification dated 18th January 2022, the determination of the degree of degradability and degree of disintegration of plastic material shall be as per the protocols of the IS listed in Schedule I to the rules, following appropriate standards developed by Bureau of Indian Standards (BIS) and certified by CPCB. The compostable plastic materials shall conform to the Indian Standard: IS 17088:2008 titled Specifications for Compostable Plastics, as amended from time to time.

The guidelines for effective implementation of EPR for "extended producer responsibility for plastic packaging" have been given legal force through the PWM Amendment Rules, dated 6th October 2021 and notified on 16th February 2022. They apply to both pre-consumer and post-consumer plastic packaging waste. Producers, Importers, and Brand Owners (PIBOs) must fulfil EPR obligations by ensuring that plastic waste is processed through Plastic Waste Processors (PWPs), as per an action plan to meet EPR targets. They are required to obtain certificates from PWP according to the quantity of plastic waste processed and use such certificates to meet their EPR targets. Provisions and targets for reuse (by brand owners), recycling (by PIBOs), and use of recycled plastic (by PIBOs) have also been laid out. Registration of PIBOs (operating in one or two states) and PWP shall be done by the State Pollution Control Board (SPCB) or the Pollution Control Committee (PCC) through the centralized Extended Producer Responsibility portal developed by CPCB.

The guidelines have recognized and included biodegradable plastics, as certified by regulatory entities Central Pollution Control Board, BIS, Central Institute of Petrochemicals Engineering & Technology, for adoption and will be exempted from EPR targets.

5.3 REDUCING ENVIRONMENTAL HARMS FROM PLASTICS: TECHNOLOGY EMPLOYED, PENETRATION LEVEL AND EFFICIENCY–GLOBAL AND INDIA

Several approaches are available to address the environmental side effects of rapidly growing plastics production, use, and disposal.

i. **Modifications in the design of the product**, such as using the alternative materials in place of plastics, could decrease the production, use, and discarding of plastics in the first place. Variations in design practices, such as through product weight reduction, could reduce plastic waste generation. Adoption of biobased or biodegradable plastics could reduce the adverse environmental impacts of plastics by reducing their ecological footprint.

ii. **Improving the waste management systems by implementing higher waste collection and recycling rates** would allow plastic waste to be captured before creating problems in the natural environment.

iii. **Organizing clean up and remediation events**, such as beach clean-ups and technologies to collect plastics from oceans, would facilitate the removal of plastics already present in the natural environment.

Each of these approaches has substantial possibilities and a set of associated risks and costs. The usage of alternative materials instead of plastics can reduce plastic use; however, it may amplify environmental burdens elsewhere. Replacing plastics may also nullify the use-phase energy savings (in transport, for example) that plastics can create in the first place. Using bio-based or biodegradable plastics may also have unintended consequences. In particular, improved biodegradability can intensify the spreading of microplastic fragments in the environment if degradation is incomplete. Consequently, clean up, and remediation activities can come at a high cost and are unlikely to address microplastic pollution effectively.

Recycling rates–Despite recent efforts, plastic recycling continues to be an economically marginal activity. Current recycling rates are thought to be 14–18% at the global level. The remainder of plastic waste is either incinerated (24%) or disposed of in a landfill or the natural environment (58–62%).

These recycling rates are substantially lower than those for other widely used materials. Recycling rates for primary industrial metals – steel, aluminium, copper, etc. – and paper are thought to exceed 50%. Plastic recycling rates also vary significantly across different countries, waste streams, and polymer types. Some polymers are more widely recycled than others. Recycling rates for PET and high-density polyethylene (HDPE) commonly exceed 10%, while those for polystyrene (PS) and PP are closer to zero. Recycling rates in the EU average 30% and are thought to be considerably higher in some EU Member States (Figure 10). Recycling rates in other high-income countries are typically in the order of 10%. Recycling rates in low- to middle-income countries are largely unknown but may be significant in situations where there is a well-established and effective informal sector. Data indicates that plastics recycling rates may be approaching 20–40% in some developing country cities.

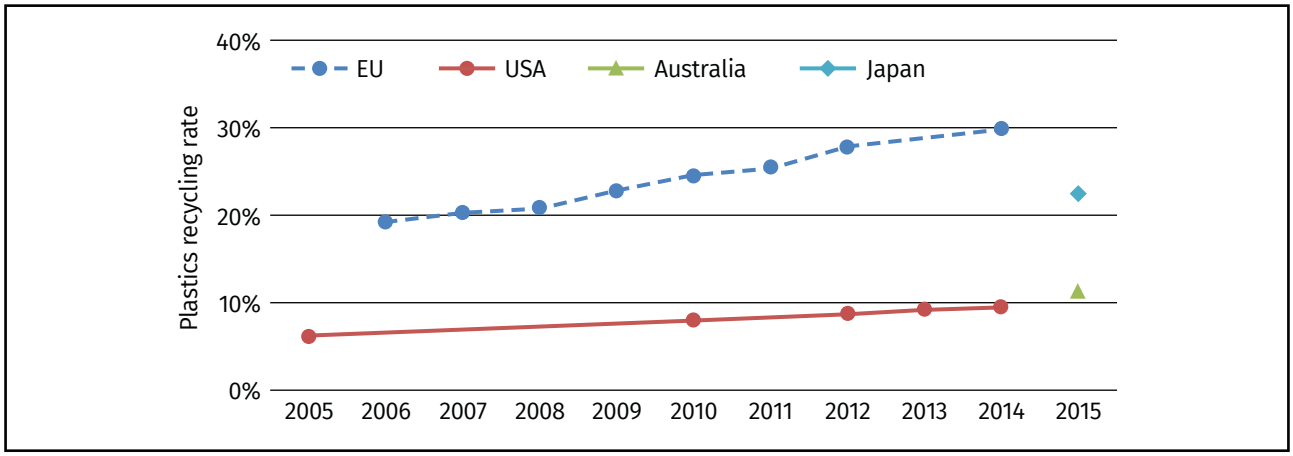


Figure 10: *Recycling rates in selected high income countries*

Source: *OECD: Improving Markets for Recycled Plastics: Trends, Prospects and Policy Response (2018)*

Recycled plastics market share–Production statistics for recycled plastics are mainly unknown, however, data provided in Geyer, Jambeck and Law allows some rough approximations. A global plastics recycling rate of 18% and plastics waste generation of 258 MTPA (both resins only) translate into approximately 46 million tons of recycled plastics production per year. This represents 12% of total global plastics production but is likely to be an upper estimate because, in some cases, the material that is reported as "recycled" may refer only to the material diverted towards recycling: some proportion of this is likely to become recycling residues that require disposal[20].

While governments have an essential role to play, these efforts are more effective when coupled with private industry action and technological innovation, especially given the global nature of the problem and the range of stakeholders involved. To that end, both for-profit and non-governmental organizations (NGOs) are trying to reduce the negative impacts of plastic pollution by developing new technologies designed to remediate plastic pollution in the environment. For example, new technologies and strategies to remediate plastic pollution have been compiled by Ubuntoo. This for-profit company shares innovative solutions developed by private entities, NGOs, governments, and academics in a web-based database. Additionally, for-profit entities such as Systems, Applications, and Products in Data Processing (SAP), Modis, Cermaq, and Wilhelmsen supported the United Nations

20 https://www.oecd.org/environment/waste/policy-highlights-improving-plastics-management.pdf

(UN) Reboot the Ocean Challenge, to reduce marine plastic pollution[21].

These innovative techniques to reduce the amount of global plastic pollution focus on different life cycle stages of plastic, including production, consumption, and waste management, which can involve landfilling, recycling, or repurposing (*e.g.*, waste-to-energy). Approximately 80% of marine plastic pollution arrives in the ocean from land-based sources. It is common for plastic to leak out of waste management channels into the environment as mismanaged waste throughout the production, consumption, and waste management stages of the plastic life cycle. For example, plastic can be lost to the surrounding environment and transported to the oceans via waterways, winds, and tides due to littering and improper waste management in open or uncontrolled landfills.

Microplastics can enter the environment through wastewater, storms, and catastrophic events, which can carry materials of all kinds, including plastics, into the oceans. Technologies addressing these issues are geared toward either 1) directly preventing plastic leakage into waterways or 2) collecting existing plastic pollution. During the recycling phase, innovative recycling solutions, such as plastic-to-fuel and bioremediation, are being explored. These technologies serve as good complements that can work in tandem with policy efforts to combat marine plastic pollution (Table 1).

Table 1: Plastic pollution prevention and collection technology inventory

Methods		Name	Year	Description	Used	Location invented	References
Prevention: macroplastics	Stormwater and wastewater filters	StormTrap TrashTrap	2018	Mesh net system uses water flow to capture and remove trash, floatables, and solids from stormwater and wastewater	Yes	United States	TrashTrap: Capture floatables with innovative netting systems[22]
		PumpGuard	2016	Mesh nets remove debris from stormwater and wastewater	Yes	United States	Pump protection solutions for wastewater, stormwater and combined sewer overflow (CSO) discharges
		CLEVER-Volume	2019	Sensors allow port authorities to certify the amount of ship waste reported in comparison to the volume reported to MARPOL inspectors	No	Portugal	CLEVER-Volume – 3D Modelling[23]

21 Schmaltz, E., Melvin, E.C., Diana, Z., Gunady, E.F., Rittschof, D., Somarelli, J.A., Virdin, J. and Dunphy-Daly, M.M., 2020. Plastic pollution solutions: emerging technologies to prevent and collect marine plastic pollution. Environment international, 144, p.106067.

22 https://stormtrap.com/wp-content/uploads/2018/06/TrashTrap-Specification.pdf

23 https://www.3dmodelling.eu/clever-volume/

Methods		Name	Year	Description	Used	Location invented	References
Prevention: macroplastics	Miscellaneous leakage prevention	Unnamed Invention by Students at Gering High School	2017	Gravity-fed, three-stage attachable filter catches microplastics (e.g., microfibers shed from the laundry) before they enter the wastewater	No	United States	These students found a way to keep microplastics out of your drinking water[24]
		GoJelly Project	2018	Jellyfish mucus (secreted when they reproduce or become stressed) captures and binds to nano-sized particles, removing microplastics from wastewater	No	Unknown (Funded by EU)	Diaz, 2019[25]
	Laundry balls	Cora Ball	2019	Balls placed in the laundry machine capture microfibers shed when washing synthetic fibres	Yes	United States	Ball, 2020[26]
		Fibre Free	2017	Balls placed in the laundry machine or dryer capture microfibers shed when washing or drying synthetic fibres	No	United States	Chou, 2018[27]
	Residential wastewater treatment	Lint LUV-R	2016	The water filter on laundry machines captures microfibers when water is drained through the machine	Yes	Canada	Lint LUV-R washing machine discharge filter[28]

24 https://www.marthastewart.com/1528235/high-school-students-invent-filter-microplastics

25 Diaz, S., 2019. A solution to microplastic pollution, thanks to jellyfish? Science News.

26 https://doi.org/10.1016/j.scitotenv.2019.03.258

27 Chou, A., 2018. Fibre Free founders can help change your carbon footprint, one load of laundry at a time. Syracuse University: Blackstone LaunchPad.

28 https://www.nationthailand.com/news/30371707

Methods		Name	Year	Description	Used	Location invented	References
Collection: macroplastics	Large-scale booms	Holy Turtle	2018	1,000foot-long floating unit is towed by two marine vessels and captures floating waste; a large vent hole protects marine life	Yes	United States	Kotecki, 2018[29]
	Drones and robots	FRED (Floating Robot for Eliminating Debris)	2019	Solar-powered vessel with conveyor belts collects floating debris	Yes5	United States	About – Clear Blue Sea[30]
		Jellyfishbot	2018	A remote-controlled robot collects garbage from waterways	Yes	France	A jellyfish robot arrives in the Old Port to collect waste[31]
		BluePhin	2017	A battery-powered, zero carbon emissions robot uses artificial intelligence to collect floating waste	Unknown	United Arab Emirates	BluePhin Technologies[32]
Collection: macroplastics	Boats and wheels	The Interceptor	2019	Solar-powered catamaran autonomously extracts floating plastics from rivers, using barriers and a conveyor belt	Yes	Netherlands	How it works: The interceptor[33]
		MariClean	2020	Catamaran fitted with a conveyor belt collects debris from seas, straits and bays	No	Canada	Echavez, 2020[34]

29 Kotecki, P., 2018. SodaStream built a 1000-foot-long contraption called the "Holy Turtle" to collect plastic from the ocean. Business Insider

30 https://www.clearbluesea.org/about-3/

31 https://www.iadys.com/en/jellyfishbot-2/

32 BluePhin Technologies. https://bluephin.io/

33 https://theoceancleanup.com/rivers/

34 https://ideas.unite.un.org/Page/ViewIdea?ideaid=9164

Methods		Name	Year	Description	Used	Location invented	References
Collection: macroplastics	Detection aids	Malolo I	2017	The unmanned aerial robot detects marine debris (especially fishing gear) in the open ocean for later collection or satellite tagging	Yes	United States	Mayer, 2017[35]
		Unnamed GPS Device on Ghost Nets	2019	Vessels place GPS units on ghost nets to mark them for collection	Yes	United States	Ocean Voyages Institute, 2020[36]
		NetTag	2019	Low-cost transponders allow fishers to locate and recover lost nets	Yes5	England	E&T Editorial Staff, 2019[37]
		Wikilimo	2019	Uses satellite imagery to detect significant garbage patches in oceans; uses numerical models and machine learning to identify optimum routes for cleaning up garbage patches	No	United States	Machine learning and satellite imagery-based oceanography[38]
	Waterway litter traps	SCG Litter Trap	2019	A floating litter trap uses a bypass flap to leverage water flow and pressure to capture and trap floating litter	Yes	Thailand	Litter trap' a success blocking trash from the sea; SCG's Floating Litter Trap to Prevent Marine Debris Entering Oceans at Rayong Estuaries and Samut Sakhon Canals[39]

35 https://sanctuaries.noaa.gov/missions/nwhi2008/marinedebris.html

36 https://www.oceanvoyagesinstitute.org/

37 E&T Editorial Staff, 2019. Low-cost transponders could stop 'ghost nets' from wreaking havoc on marine life. Engineering Technology

38 https://wikilimo.co/oceanography

39 https://www.scgchemicals.com/en/newsmedia/news-events/press-release/detail/449

Methods		Name	Year	Description	Used	Location invented	References
Collection: macroplastics	River booms	The Litterboom Project	2017	Large pipes anchored across rivers catch surface-level debris	Yes	South Africa	About the project[40]
		Plastic Fischer Trash Boom	2019	Boom made of PVC pipe floaters and galvanized steel catching nets collect surface plastics up to 60 cm deep	Yes	Germany	Our solutions[41]
	Sand filters	Barber Surf Rake	Unknown	Tractor-towed machine removes waste on beaches	Yes	United States	Surf Rake—Tractor-towed beach cleaner machines[42]
		Barber Sand Man	Unknown	Walk-behind sand sifting machine uses a vibrating screen to shift debris from sand and soil on beaches	Yes	United States	Walk-behind sand cleaner[43]
	Miscellaneous capture	Unnamed Invention by Anna Du	2018	Remotely operated vehicle uses infrared light to detect, photograph, and help remove microplastics from waterways	No	United States	Anna's World[44]
		Unnamed Invention by Fionn Ferreira	2019	Combination of oil and magnetite powder binds microplastics for extraction with a magnet	No	Ireland	What is Fionn About[45]

40 https:// www.thelitterboomproject.com/about.

41 https://plasticfischer.com/trashbooms

42 http://www.hbarber.com/Cleaners/SurfRake/Default.html

43 http://www.hbarber.com/Cleaners/SandMan/Default.html

44 https:// www.annadu.org/

45 https://www. fionnferreira.com/about

Methods		Name	Year	Description	Used	Location invented	References
Collection: all	Vacuum	Hoola One	2019	Vacuums approximately three gallons of sand and debris per minute into a tank that separates particles by buoyancy, allowing for plastic separation and removal	Yes	Canada	Hoola One microplastic removal machine arrives in Hawaii, 2019[46]
	Air barrier	The Great Bubble Barrier	2019	Tubes placed diagonally across the bottom of the waterway create a bubble barrier by pumping air, creating a current that brings debris to the surface and guides it to a catchment system	Yes	Netherlands	Bubble barrier catches micro-plastics from effluent sewage treatment[47]

The best practices as reported by the SPCBs/PCCs in their 2019-20 Annual Report are summarized in Table 2 below:

Table 2: Best practices in plastic waste management

Sl. No.	State	Best Practice
1	Andhra Pradesh	Plastic waste collected from local bodies or biomining sites is sent for co-processing in cement plants
2	Arunachal Pradesh	Plastic banks were established in one district; Plastic was used in Road Construction in variable districts
3	Goa	Non-biodegradable waste is sent to co-processing plants for which bailing plants have been set up by Goa Waste Management Agency, Local bodies as well as Village Panchayats
4	Gujarat	94000T of plastic waste was sent for incineration during 2019-20s.
5	Haryana	All municipal corporations have been directed to set up material recovery facilities. 41 out of 81 MCs have set up the MRP

46 https://www.bigislandvideonews.com/2019/04/25/video-hoola-onemicroplastic-removal-machine-arrives-on-hawaii/

47 https://www.dutchwatersector.com/ news/bubble-barrier-catches-micro-plastics-from-effluent-sewage-treatment

Sl. No.	State	Best Practice
6	Jharkhand	Reverse Vending machine has been installed at Ranchi, Dhanbad & Jamshedpur cities for recycling of plastic bottles as a pilot project; ULB-wise Action Plan prepared for management of plastic waste; Plastic waste being co-processed/used in road construction
7	Kerela	Plastic is used for tarring roads
8	Lakshadweep	10 Material Recovery facilities established
9	Madhya Pradesh	Over 1,00,000 tons of plastic waste are co-processed in cement kilns; 75,000 tons are processed by recyclers; 2000 tons are used in road construction within and outside the state; 150 tons are used in pyrolysis plant
10	Maharashtra	Collection efficiency 78%; recycling & co-processing 62%; pyrolysis & road construction >5000TPA each
11	Manipur	21 out of 27 units segregating plastic waste and sending it for recycling, co-processing & road construction
12	Meghalaya	Co-processing to be initiated; plastic usage in road construction started
13	Mizoram	308 plastic and bottle collection centres set up in 280 villages are constructed; procured six nos. of bailing machines; agreement signed with WMA for collection and processing of waste
14	Nagaland	Usage of plastic waste in road construction initiated
15	Odisha	Plastic waste has been included in the Schedule of the rate department for the use of the same in road construction
16	Puducherry	Usage of plastic in road construction & co-processing initiated
17	Sikkim	Usage of plastic waste in road construction initiated
18	Tamil Nadu	Collection efficiency of plastic waste is 92%, 468 MRFs established; approx. 3,50,000 MT of plastic was sold, and INR 89,00,00,000 was generated as revenue which was distributed to sanitary workers during the period August 2017 to March 2020; 655 tons of plastic waste were used for constructing 535 km of the road; 116 ULBs have entered into an agreement with cement companies for disposing of 20,000MT of plastic waste; more than 400 tons of waste used in pyrolysis plants
19	Telangana	134 Dry Resource centres established in 111 ULBs
20	Uttarakhand	The use of plastic waste as fuel, RDF and waste in energy plants is proposed; the use of plastic waste in road construction initiated

Sl. No.	State	Best Practice
21	A&N Island	Enforcement drive for enforcement of the ban on plastic items. Exhibitions organized to promote an alternative to plastic items
22	Delhi	Environmental compensation of INR 88,00,000/- levied for violation of PWM Rules
23	Himachal Pradesh	Plastic waste is used in waste to energy plants; co-processing, and road construction
24	Karnataka	Plastic waste (approx. 75,000 tons) was sent for recycling, and around 50,000 tons was sent for co-processing
25	Uttar Pradesh	2 waste to oil units with a capacity of 2700 TPA set up; Plastic usage in road construction initiated; Paper mills have tied up with cement mills for co-processing their waste

Plastics and oceans

Different countries release disproportionate volumes of plastic waste into the ocean, and once plastic enters the sea, it is transported by waves and currents to various depths and ocean ecosystems. The top five countries in mismanaged plastic waste in this regard are China, Indonesia, the Philippines, Vietnam, and Sri Lanka[48]. Additionally, Asian rivers have been estimated to represent 86% of the total plastic releases into rivers globally, making China, India, Bangladesh, and Indonesia countries of particular concern[49].

Given the scope and cross-boundary nature of this problem, solutions will need to involve international actors acting across multiple scales. Nations will need to work together to address the issues of plastic in areas beyond national jurisdictions. The utility of technologies in the inventory table above could be enhanced if policymakers and other stakeholders work together across jurisdictions to ensure technologies are deployed in areas where they could do the most good[50]and are able to reach viable scale quickly.

5.4 EMISSIONS REDUCTION THROUGH RECYCLING AND UPCYCLING

Waste management generates greenhouse gases both directly and indirectly. Direct emissions are generated

- during waste collection and transportation;
- during waste pretreatment (sorting, crushing etc.);
- in waste utilization processes;

48 Jamb Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman, M., Andrady, A., Narayan, R. and Law, K.L., 2015. Plastic waste inputs from land into the ocean. Science, 347(6223), pp.768-771

49 Leb Lebreton, L., Van Der Zwet, J., Damsteeg, J.W., Slat, B., Andrady, A. and Reisser, J., 2017. River plastic emissions to the world's oceans. Nature communications, 8(1), pp.1-10

50 Schmaltz, E., Melvin, E.C., Diana, Z., Gunady, E.F., Rittschof, D., Somarelli, J.A., Virdin, J. and Dunphy-Daly, M.M., 2020. Plastic pollution solutions: emerging technologies to prevent and collect marine plastic pollution. Environment international, 144, p.106067.

- in landfills during decomposition;
- in waste combustion; and
- in biological treatment

Additionally, indirect greenhouse gas emissions are connected to waste through other functions such as

- energy consumption related to the production, transportation and use of the material;
- emissions from production processes (not related to energy consumption); and
- emissions from the production and transportation of the raw materials for the products

Material recycling can also decrease both direct and indirect greenhouse gas emissions. Globally, the energy savings from plastic waste recycling are estimated to be 3.5 billion barrels of oil, equivalent to about $176 billion dollars[51]. Although several recycling technologies have been investigated, they suffer universally from low benefits, high costs, and secondary pollution, leading to limited practical applications. Therefore, developing cost-effective, environmentally friendly, and efficient approaches to transform plastic waste into value-added products will be critical to prevent their dispersion into the natural environment.

In addition, the development of effective catalytic-degradation technologies is essential for treating non-recoverable plastic wastes. An attractive alternative is upcycling, which aims to realize embedded value to incentivize large-scale valorization of plastic wastes and their conversion to high-value and high-performance fuels, chemicals, and materials. The degradation of non-recoverable plastic wastes is necessary to treat the omnipresent pollution. To overcome the inherent shortcomings within conventional strategies, upcycling, which emphasizes recovering the intrinsic value in plastic wastes, has been developed as a complementary and more attractive option. Comparatively, recycling highlights a “closed-loop” for the plastic materials, whereas upscaling is an open-loop process with multiple profit and economic value streams.

Moreover, upcycling processes provide new methods to handle real-world plastic wastes, which cannot be exposed to thermomechanical recycling. Hence, there is no uncertainty that plastic waste upcycling would contribute to the mitigation of solid waste contamination and the manufacture of high-value products simultaneously, thus, leading to considerable economic and scientific opportunities. Both recycling and upcycling are designed for the valorization of post-consumer plastic wastes to stop the emission of plastic wastes into the natural environment; however, they cannot deal with nonrecoverable plastic wastes. There is a wide variety of plastic waste which cannot be feasibly collected and used under current economic and technical parameters, such as plastic fragments mixed with sludge and plastic debris disseminated in the natural environment[52].

Upcycling to Chemicals

Catalytic depolymerization to monomers

This is also called chemical recycling to monomers. It is an elementary form of chemical recycling which facilitates the production of recovered plastic having properties similar to virgin plastic. It is carried out by catalytic depolymerization of initial monomers into purified monomers. At present,

51 https://www.sciencedirect.com/science/article/pii/S2666386421002186#bib28

52 https://www.researchgate.net/publication/353995174_Upcycling_and_catalytic_degradation_of_plastic_wastes

catalytic depolymerization to monomers primarily focuses upon polyesters, particularly PET, because the ester chemolysis is relatively uncomplicated.

Numerous catalytic depolymerization methods have been considered to convert PET to monomers. Few examples include hydrolysis with water to terephthalic acid (TPA) and to ethylene glycol (EG) under neutral, acidic, or primary conditions; alcoholysis with alcohol (methanol, ethanol, etc.) to dialkyl terephthalate and EG; glycolysis with excess glycols (such as EG, diethylene glycol (DEG), propylene glycol (PG), polyethylene glycol (PEG), 1,4-butanediol. and hexylene glycol) toward bis(hydroxylethylene) terephthalate (BHET or other corresponding esters) via a transesterification reaction; and aminolysis with amines (or ammonolysis with ammonia) toward corresponding diamides of TPA and EG.

Catalytic hydrogenolysis to chemicals

Hydrogenolysis is a distinct type of depolymerization. It disrupts the chemical bonds, in particular, C–C bonds, with the assistance of hydrogen (H2). In some cases, selective deconstruction of plastics can be carried out through hydrogenolysis to short-chain products with values that are substantially higher than the fully deconstructed monomers. Currently, plastic waste upcycling to derive value-added chemicals via direct hydrogenolysis mainly focuses on PET and PE. However, when compared with depolymerization, catalytic hydrogenolysis offers more accessible and promising options for converting PET wastes into valuable chemicals and the drop-in combination of plastic valorization with well-established industrial processes toward an ideal circular economy. Catalytic hydrogenation of strong Polyamides (PAs) is complex since they have high resistance to most solvents because of the multiple intermolecular solid hydrogen bonding interactions within the polymer chains. The advantages of this catalytic system are its affordability and the exceptional reusability of the catalyst, but silanes are very expensive.

Other routes to valuable chemicals

Direct hydrogenolysis of polyolefins, including PE and PP, often yields mixed alkanes with a broad molecular distribution instead of well-defined monomers, even when elaborately designed catalytic systems are used. The consumption of expensive H_2, which fundamentally originates from non-renewable fossil fuel resources, is a primary hindrance to the application of hydrogenolysis technologies. Tandem catalysis, which refers to integrating several reaction steps into one-pot catalytic systems in a suitable sequence through precise regulation of active sites, the chemical environment, and the reaction conditions, offers a promising strategy to prevent unwanted side reactions to tailor a reaction pathway and then achieve selective, efficient conversion of plastic waste to target products. Recently, upcycling of PE to long-chain alkylaromatics was developed by tandem hydrogenolysis/aromatization over a commonly used heterogeneous catalyst without consuming the external hydrogen. The liquid alkylaromatics can be used as feedstocks to produce various daily products, viz., surfactants, lubricants, refrigeration fluids, and insulating oils.

Upcycling to polymers

The monomers derived from plastic depolymerization are usually returned to the manufacturer of the original plastic. In addition, the monomers and their derivates derived after further chemical or enzymatic transformation can be used to produce new materials. Another option is to incorporate plastic-derived monomers, oligomers, or even polymer fragments into new materials through copolymerization with external building blocks. Aminolysis of PET and BPA-PC delivers

various modular frameworks for new polymer production. The use of plastic waste as the feedstock in additive manufacturing creates a new path for plastic recycling and upcycling towards a circular economy. In another example, acrylonitrile butadiene styrene in the waste from children's toys was successfully transformed into filaments comparable to virgin materials[53].

5.5 RECYCLED PLASTIC INTO USEABLE PRODUCTS

The following types of plastics are converted into useable products[54].

1. PET is recycled to make apparel, blankets, carpets, tote bags, other winter wear like fleeces, containers for food, beverages, automotive parts, film, strapping and industrial end-use items (e.g. geotextiles and roof insulation).
2. PP and HDPE are often collected by local scrap dealers to recover the costs of collection, sorting and pre-processing. The PP is further divided into several categories such as coloured, mixed colour, white, transparent and other recycling categories. The resin in each category is the same. However, it requires sorting post collection and is subject to independent unit operations. The value and demand for transparent PP are pretty high.
3. Plastic sheets are made up of plastic types ranging from LDPE, PP and HDPE. These are procured at a rate of Rs 6–15/Kg by local scrap dealers as mixed plastic bags and sheets. They are further sub-segregated manually to be channelized to the relevant pre-processing and treatment facilities.
4. PVC can be divided into rigid PVC, soft PVC and footwear. Chlorinated PVC is considered to be a lower grade of PVC as compared to unplasticized PVC as it degrades after undergoing recycling. Also, as the PVC plastics go through the process of recycling, the colour of the plastic starts to turn grey, which darkens further as the PVC plastic undergoes more iterations of the recycling process.
5. Polycarbonates are thermoplastics bought by the scrap dealers at a rate of Rs 50/kg, and they are used in engineering as they are rigid materials, and some grades are optically transparent, which makes them display properties of glass without the brittleness. This optical transparency gets diminished over multiple cycles of recycling, but it can still be used for engineering purposes. Nylon, which is also known as polyamide (PA), is widely used in household plastic items like clothing and toothbrushes and also has industrial uses like in conveyor belts and as machinery parts. It is usually procured along with various types of plastics and then sub-segregated and sorted manually to be further sold to processors at a rate of Rs 20–35/Kg depending on the type and quality of the material.

The above mentioned are the major categories of plastics that are used, recycled and sold on the market. However, the cost of recycled plastics and their products makes it hard to compete with the products made from virgin material. There are two prime reasons for this.

- First, the raw material used for the production of virgin plastic is a waste material from the petroleum industry and therefore available at throw-away costs.
- Second, the unorganized recycling business is labour dependent and intensive, mainly

53 Hou, Q., Zhen, M., Qian, H., Nie, Y., Bai, X., Xia, T., Rehman, M.L.U., Li, Q. and Ju, M., 2021. Upcycling and catalytic degradation of plastic wastes. Cell Reports Physical Science, 2(8), p.100514.

54 Singh, S.G., 2021. Plastic Recycling: Decoded.

due to sub-segregation and sorting, which is not done at the source in the country. This adds costs to the recycled plastic raw material.

The imposition of GST[55] has had a significant impact on the plastic recycling sector. There existed a taxation gap between recycled and virgin plastic products before GST was introduced. For instance, recycled polyester staple fibre (PSF) had a 2% excise duty, while virgin PSF had a 12.5% excise duty. After GST implementation, the taxes stood at 18% for both virgin and recycled plastics. Input costs escalated by 16% due to the new tax regime. In a situation where market linkages for recycled products are weak and the availability of plastic scrap is intermittent, the business models within the recycling sector struggle to become viable. The plastic recyclers are the most affected if plastic scrap is imported. These input cost escalations due to GST and customs duties are passed on by the recyclers to the secondary waste collectors by reducing the rates of waste plastic. In 2017, GST rates for domestic plastic scrap were reduced from 18 per cent to 5 per cent. However, the per-unit rate of waste plastic is still not comparable to the pre-GST era. The reason is that in the pre-GST taxation regime, domestic plastic scrap was tax-free. The selling prices for recycled granules have been affected by similar GST rates on virgin and recycled granules. Recyclers are bound to keep the selling price low to stay competitive with virgin granules. This has affected the revenue of recyclers and also limits the market scale-up of recycled granules.

The market for recycled plastics/secondary raw material

The demand for recycled plastic raw materials can be segmented into two parts:

i. extended recyclers (recyclers who process scrap and convert it to end-products) and

ii. plastic product manufacturers (end product manufacturers who purchase recycled plastic resins as raw material).

Formal recyclers face challenges in acquiring a high-quality supply of plastic waste as current collection systems are dominated by the informal sector. Further, the processing cost of scrap is high in the formal sector if occupational health and safety conditions are met. These factors make it challenging for recycled plastic to compete with low cost virgin plastic. It is easier to compete in segments that do not currently use plastics as raw material. For example, alternative building materials made out of recycled plastics in the form of plastic bricks and planks can be used instead of conventional materials such as clay and mortar bricks in building construction.

Plastic product manufacturers focus only on a limited market for post-consumer resin (recycled plastic pellets). This is driven by the low grade of recycled plastic resins produced mainly due to operations in a fragmented market. There is a potential to penetrate export markets, such as Europe, where there has been a rise in the demand for sustainable products and circular consumption. But to tap these markets, the manufacturers of post-consumer resin need to meet higher quality standards demanded by foreign buyers.

5.6 CIRCULAR ECONOMY OF PLASTIC WASTE MANAGEMENT[56]

Circular economy models retain the added value of goods as long as possible, reducing waste and restricting the circulation of plastics in the economy without leakage into the natural environment.

55 https://cdn.cseindia.org/attachments/0.97245800_1570432310_factsheet3.pdf

56 https://www.teriin.org/sites/default/files/2021-12/Circular-Economy-Plastics-India-Roadmap.pdf

However, the manner in which most plastic products are created, used, and disposed of in the present day does not capture the economic advantages of a more circular approach and end up with severe harms to the environment. Also, nearly every piece of plastic begins as fossil fuel and releases greenhouse gases during its extraction, processing, usage, and end-of-life at each point of the plastic lifecycle.

The circularity roadmap for plastics presents an entire value chain and aims to decouple plastic production from virgin fossil feedstock, incentivize plastic recycling and reuse, and reduce damage by plastic litter while decreasing unnecessary plastic consumption. It has set three key objectives, supported by a measurable action plan that may be monitored over short (0–2 years), medium (2–5 years), and long term (>5 years). These objectives are:

i. Adopting sustainable material solutions, such as the use of bio-based polymers, the substitution of virgin polymer with recycled polymer, and the dematerialization of plastic products

ii. Increase the supply of good quality secondary plastics feedstock; and

iii. Invent, innovate, and encourage alternative uses of plastics waste

It will also require monitoring these action points regularly and systematically along with appropriate data collection and analysis to determine efficacy and need for adjustment in the steps defining the roadmap.

A resource-efficient circular economy for plastics is one that minimizes wasteful use of plastics, produces plastics from renewable sources, is powered by renewable energy, reuses and recycles plastics within the economy without leakage to the environment, and generates no or minute waste or emissions. There have been collaborative initiatives such as the United Nations Development Programme (UNDP) India, in partnership with Hindustan Coca-Cola Beverages Private Limited (HCCBPL), which encourages sustainable PWM practices and fosters a move towards a circular economy in 50 cities and towns in India, there are many challenges in adopting circularity of plastics in India.

Demand-side potential: key end-use sectors–Plastics are used for a variety of purposes across application categories and end-use sectors. For instance, packaging is broadly categorized into rigid packaging and flexible packaging. Flexible packaging has the largest share within the key end-uses. It also forecasted to see strong growth in the future due to several advantages, such as ease in handling and disposal, price advantage in transportation etc. (Table 3–5).

Table 3: Plastics circularity in the packaging sector

Circularity Aspect	Existing Practices/Scope (International and Indian context)	Opportunities
Use of bio-plastics	✦ Around 60% of total bio-plastics consumption in India is for packaging ✦ Used in making bottles, loose-fill, cups, pots, blows, flexible films, etc. ✦ In India, selected FMCG companies are aiming for 100% biodegradable plastics for packaging ready-to-eat and cosmetic products	✦ Use of PBS as alternatives in packaging, include the use in fresh food packaging to enhance lifespan ✦ With bans against SUPs and economics of scale setting in for bio-plastics, their share in the packaging sector is expected to increase

Circularity Aspect	Existing Practices/Scope (International and Indian context)	Opportunities
Reusable packaging	✦ Pepsico India, scaling up its non-returnable glass bottles for its packaging ✦ Leadec India provided reusable crating solutions for automotive components made of HDPE that can be folded ✦ Reffin aims to offer restaurants with an alternative means of delivering their food to consumers by using tiffin carriers, generally made out of stainless steel	✦ Many reuse opportunities in business-to business (B2B) applications, which are generally better understood and adopted at scale already ✦ Designing packaging solutions in business to-consumer (B2C) applications ✦ Potential to meet individual needs. Specificities for packaging, improved user experience and create brand loyalty ✦ Replacing existing SUP containers in the growing online food delivery services by using re-usable containers
Use of recycled plastics	✦ Commitment by large companies (both Indian and MNCs) will move to 100% recyclable plastic packaging by 2025 ✦ Cargill Oils India, in association with Dow Chemical, reformulated its plastic material, making 90% of its plastic packaging recyclable	✦ Use recycled plastic in non-food applications ✦ Inclusion of pro-environment message on the packages and to nudge the consumer towards responsible behaviour that includes giving preference to products containing recycled raw material
Re-design of packaging	✦ Lush handmade cosmetics have a packaging free line ✦ Cargill's oil business in India has redesigned its packaging by cutting down on the amount of raw plastic used across all products ✦ Cremica Food Industries is reducing lamination in packaging	✦ Avoid use of extra packaging material or create packaging free line of products ✦ Fewer types of standardized plastics for specific uses in FMCG-reduce plastic waste leakage and improve recycling ✦ Replacing packaging material like shrink wraps with more durable and reusable long lasting alternatives ✦ Stay on tabs for beverages, flip flop caps for FMCG products ✦ Replacing multi-polymer plastic packaging with single polymer plastic packaging ✦ Colour coding and labels for disposing bio-based or compostable after use

Table 4: Plastics circularity in the automotive sector

Circularity Aspect	Existing Practices/Scope (International and Indian context)	Opportunities
Use of bio-plastics	✦ Successful pilot experiments have been completed on the use of bio-based plastics for automotive applications ✦ The most important upcoming market within the automotive sector is technical applications. Currently, the automotive and transport sectors account for 1% of the bio-plastics market segment	✦ Bio-based polyesters, bio based PET and PLA-blends in applications such as headliners, sun visors and floor mats, interior fabrics
Use of recycled plastics	✦ Currently, recycled plastic account for 15% in vehicles ✦ TATA Motors engaged in automotive bumper recycling	✦ Plastic fibres made from used bottles in sound insulation layers in dashboards ✦ Use of plastics recycled from bumpers to create new bumpers, as well as plastics recycled from bottle caps to make new auto parts ✦ Use of recycled plastic content in vehicles is expected to increase to 70%
Use of eco design practices	✦ BMW uses hemp as well as natural fibres along with acrylic polymers for manufacturing interior door panels ✦ Ford uses bio-polymers from soyabean along with polyurethane to manufacture head rests in select models ✦ Nissan Leaf uses natural fibres from corn along with Sorona (polytrimethylene terephthalate) for manufacturing of rugs and mats	✦ Natural fibres or biopolymers draw significant interest from equipment manufacturers due to their biodegradability, low cost, low relative density. high specific strength, and renewable nature ✦ Eco-design approach gets product design environmental oriented

Table 5: Plastics circularity in the building and construction sector

Circularity Aspect	Existing Practices/Scope (International and Indian context)	Opportunities
Use of alternative materials	✦ Bricks and planks made out of plastic waste being used as alternatives to traditional clay and mortar bricks in construction	✦ Biological nutrients and sustainable, renewable materials can replace materials that are heavily processed and hard to reuse and recycle

Circularity Aspect	Existing Practices/Scope (International and Indian context)	Opportunities
Standardized approaches	✦ The utilization of Energy Conservation Building Code and implementation of green rating systems like the Green Rating for Integrated Habitat Assessment (GRIHA) is leading to resource efficient buildings in India	✦ Assessing performance of secondary materials in products replaces virgin materials and in the design of construction products ✦ By standardizing technology, construction companies can reduce their cost of production
Use of recycled plastics	✦ Royal Melbourne Institute of Technology researchers developed a building material made from cigarette butts mixed with plastic waste, bitumen, and paraffin wax ✦ Corepla along with Waste Free Oceans built the first humanitarian shelter prototype by collecting plastic waste along the river ✦ Benagluru-based non-profit Swachha developed a solution that can convert discarded plastic waste into tiles and irrigation pipes. In association with the Bruhat Bengaluru Mahanagara Palike (BBMP), Swachha developed 'Re-Tile' tiles, which customers can use on pavements	✦ Recycled plastic blended with virgin plastic lowers the cost ✦ Recycled plastic can save the cost of other materials, such as wood and slate ✦ Recycled plastics can be used to make stronger concrete structures in the form of sidewalks, driveways

Supply-side potential

Plastic feedstock–The feedstock process for making plastics causes emissions, and the economics also impact the recycling efforts with the resulting plastics being primarily non-biodegradable. Polymers such as polybutyrate adipate terephthalate (PBAT), polybutylene succinate (PBS), polycaprolactone (PCL), and polyvinyl alcohol (PVA) exist that are biodegradable fossil fuel-based polymers as their chemical structures can be broken down by the action of microorganisms in the presence of light, oxygen, and moisture.

Bio-based plastics are created using non-fossil-fuel feedstock, usually organic materials such as plant fibres (flax, jute, hemp), wood (reclaimed wood fibres from mills and agricultural waste), and starches; however, similar to the fossil fuel-based plastics, they exist in numerous grades and have a wide variety of properties. They often have an appearance very close to conventional plastic products and are difficult to distinguish by consumers other than by scientific analysis. If they contain both renewable and fossil-fuel-based carbon, they are then only partially bio-based. There is a considerable variation between the amount of bio-based constituents and the conditions under which these polymers biodegrade.

Circularity scenarios: integrating demand-and supply-side potentials

Three scenarios have been defined for India to comprehend the potential impact of resource efficiency and circular economy (RE&CE) measures from the demand and supply side of the plastics sector (Table 6):

Business as a usual scenario: A standard economic growth model is assumed where plastic product consumption and plastic waste generation increase at a fixed rate. Existing innovations and business models at the downstream stage of the value chain focusing on PWM at the public and private sector levels continue, with new ones emerging. However, these innovations and models are primarily localized with no upscaling and replication. Further, no explicit circularity efforts are put in at the upstream stages.

Moderate RE&CE scenario: Moderate reduction in virgin plastic demand by replacing it with recycled/ secondary plastic, which is derived from improved PWM. Businesses are aiming to comply with PWM legislations and have initiated the implementation of EPR, predominantly for collection and resource recovery targets. Legislative measures such as the ban on SUPs and on certain types of packaging are coming into effect. The GoI is pushing towards developing affordable substitutes/alternatives to SUPs.

High ambition RE&CE scenario: The demand for virgin plastic is considerably reduced due to a combination of circularity fostering actions that constitute increased recycling levels, effective application of EPR over the entire value chain of plastics (including measures that aim to reduce plastic consumption and reduce multi-polymer plastic), sustained and reinforced push by the GoI in developing affordable substitutes/alternatives to plastics, and improved enforcement of legislative measures such as banning the SUPs and certain types of difficult packaging.

Table 6: Potential resource efficiency and circularity scenarios for plastics sector in India

Sl. No.	Substitution between Plastic Polymers	Expansion of Segregated Waste Collection	Increased Recycling or Reprocessing into a Secondary Material	Design for Recycling	Reduction in Plastic Consumption
Circularity Interventions and Scenarios	✦ Move to bio-based as alternative feedstock to fossil feedstock ✦ Shift from multi polymer material to mono-polymer material	✦ Improved collection and transportation infrastructure ✦ Awareness generation	✦ Increase mechanical recycling capacity and efficiency ✦ Scale up chemical recycling capacity	✦ Fewer types of plastics to reduce the complexity in plastic waste management ✦ Design to enable easy disassembly at the EoL	✦ Use of alternatives to plastics products and reduction in specific uses ✦ Reuse of end use products ✦ Design to bring in efficiency in plastic raw material use
Business as usual scenario	✦ Bio-based plastics account for less than 1% of the plastics produced ✦ Use of multi polymer material continues to grow	✦ No change in segregation of waste plastic and collection levels. Important to note, collection levels in urban India are currently high but the issue is linked to unsegregated collection and irresponsible dumping and littering post collection	✦ Limited increase in overall recycling of plastics (at rates witnessed over the last 3-5 years) brought by new localized initiatives and business models. ✦ Increased awareness generation brought about by IEC activities	✦ R&D process not initiated	✦ Very limited substitution brought about in specific applications including those related to SUP

Sl. No.	Substitution between Plastic Polymers	Expansion of Segregated Waste Collection	Increased Recycling or Reprocessing into a Secondary Material	Design for Recycling	Reduction in Plastic Consumption
Moderate RE&CE scenario (2035)	✦ Percentage share of expansion in bio-based plastics infrastructure to will increase to 10% by 2035 ✦ Reason being that the ability of these types of plastics and their applications are limited	✦ Expansion in infrastructure to support segregated collection and storage (eg. MRFS and transfer station) has been initiated ✦ Improved awareness amongst stakeholders on source segregation	✦ Moderate increase in overall recycling of plastic brought about by improvement in plastic collection and expansion of recycling capacity in the country by private and public sector; Overall recycling rate increases to 70 – 75%; the draft National Resource Efficiency policy targets 100% recycling and reuse for (PET) plastic by 2025	✦ Pilot experiments around design for recycling	✦ Some substitution brought about in all applications related to SUP: Development of innovative alternative products in a few plastic products, mostly in packaging related applications: Reducing over packaging: SUP product share decreases to 40% (reduction brought about mainly through reduction in single use plastic bags and Styrofoam products)
High ambition RE&CE scenario (2035)	✦ Percentage share of bio-based plastics reaches 40% by 2035	✦ Source segregation High increase in recycling is enforced in 90% of the cities in India: Infrastructure to support segregated collection and storage exist; Deposit refund systems/ schemes supported by digital technology are in function that enhance collection of uncontaminated waste	✦ High increase in recycling brought about by significant and step changing improvement in PWM across the country by private and public sector resulting in an overall recycling rate of plastics at 90 – 94%; Deposit refund systems/ schemes supported by digital technology are in function that enhance supply of uncontaminated plastic waste for recycling	✦ Happens and it positively impacts the recycling rates by reducing the costs linked to plastics separation from the end-of-life products and also improving the recycling per se due to reduced risk of contamination of mixed plastics	✦ High substitution brought about in all applications related to SUP; Reducing over packaging, and development of innovative alternative products in all key end use applications; SUP product share decreases to 20%

5.7 MICRO-PLASTICS POLLUTION MANAGEMENT

Microplastics are released by the continuous disintegration of macroplastics in the environment (Cole et al., 2011, Jahnke et al., 2017). Microplastic (≤5 mm) and nanoplastic (≤100 nm) pollution originates from both the direct emission of "microbeads" and "micro-exfoliates" present in household cosmetics into household wastewater as well as from the breakdown of larger plastic waste into small plastic pieces via photooxidation under solar irradiation, physical crushing, and biodegradation in the natural environment. These can be consumed by various animal organisms and also accumulate in plants, ultimately resulting in their magnification via food webs. Plastic debris can act as the means for the collection and spread of hydrophobic organic pollutants, heavy metals, and diseases. Although the direct toxicological impact of plastics on human health has not been validated, the constantly rising plastic emissions will generate multiple harmful effects. For instance, microplastics have entered the human food system through products such as seafood, tea, and vegetables, and act as a significant threat to food safety and agricultural sustainability. Moreover, microplastics have been detected in human placentas. Additionally, global GHG emissions from the plastics lifecycle are expected to rise from 1.7 Gt of carbon dioxide (CO2) equivalent in 2015 to 6.5 Gt in 2050 under current practices, contributing considerably to climate change.

Six technologies focus on microplastic pollution prevention, and all but one of these are directed toward preventing microplastics from entering the water system through residential water. These inventions, such as laundry balls and filtration systems, collect microplastics generated from laundering synthetic fabrics in the household. For example, the "Cora Ball" is a ball that is placed in a laundry machine and captures microfibers that are generated while washing synthetic clothing items[57]. The "Lint LUV-R" is a filter that is installed outside of the washing machine that captures synthetic microfibers in wastewater discharge[58]. Each of these technologies results in a significant decrease in microfibers in wastewater, which is promising; however, these technologies require consumers to purchase the systems, so current levels of use may not be widespread. Scholars have noted that market-friendly solutions overestimate the value of consumer responsibility and cannot keep pace with the rising environmental costs of the plastic pollution problem[59].

Notably, residential solutions cannot combat the microplastic problem alone; industrial leakage from processing plants is a key source of microplastic pollution. For example, while water treatment systems that remove microplastics are currently marketed toward consumers for residential use (***e.g.***, the "Showerloop," which filters water for reuse and eliminates microplastics simultaneously), government institutions could enact policies to encourage their adoption in industrial settings. In addition, governments may consider evaluating wastewater emissions standards to determine legal plastic wastewater discharge amounts permitted[60]. For example, in Austria, the equivalent of approximately 2.7 million PET bottles by weight gets discharged annually into aquatic environments through industrial microplastics in wastewater emissions. The governments could provide subsidies or tax incentives to companies that institute new technology or practices to reduce plastic consumption. These financial incentives could be used to promote the installation and adoption of these technologies or to scale

57 https://doi.org/10.1016/j.scitotenv.2019.03.258

58 https://www.nationthailand.com/news/30371707

59 Dauvergne, P., 2018. Why is the global governance of plastic failing the oceans?. Global Environmental Change, 51, pp.22-31

60 https://www.researchgate.net/profile/Aaron-Scholz-Lechner/publication/273094646_The_discharge_of_certain_amounts_of_industrial_microplastic_from_a_production_plant_into_the_River_Danube_is_permitted_by_the_Austrian_legislation/links/59f5a654a6fdcc075ec4ca06/The-discharge-of-certain-amounts-of-industrial-microplastic-from-a-production-plant-into-the-River-Danube-is-permitted-by-the-Austrian-legislation.pdf

up these efforts into larger systems that could be adopted for industrial use[61].

Given the constant generation of microplastics from macroplastics in the environment, microplastic prevention and collection technologies need to be paired with macroplastic prevention and collection technologies in the background and in industrial wastewater systems.

5.8 SINGLE-USE PLASTICS

In the 4th UN Environment Assembly held in 2019, India piloted a resolution on addressing SUP product pollution, recognizing the urgent need for the global community to focus on this fundamental issue. During India's Independence Day speech in 2019, Prime Minister Shri. Narendra Modi had pledged to make India free of SUP by 2022.

MoEF&CC notified the PWM Amendment Rules on 12th August 2021, which prohibits identified SUP items with low utility and high littering potential by 2022. The manufacture, import, stocking, distribution, sale, and use of the following SUP, including PS and expanded PS, commodities shall be prohibited with effect from the 1st July 2022:

a. earbuds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, PS (thermocol) for decoration.

b. plates, cups, glasses, cutlery such as forks, spoons, knives, straws, trays, wrapping or packing films around sweet boxes, invitation cards, cigarette packets, plastic or PVC banners less than 100 microns, stirrers.

To stop littering due to lightweight plastic carry bags, with effect from 30th September 2021, the thickness of plastic carry bags has been increased from 50 microns to 75 microns and 120 microns with effect from 31st December 2022.

India plastic challenge – Hackathon 2021

To spur innovation and entrepreneurship in tackling plastic waste pollution and eliminating SUP, MoEF&CC announced the "India Plastic Challenge – Hackathon 2021". The unique competition called upon startups, entrepreneurs, and students of Higher Education Institutions (HEIs) to develop innovative solutions to mitigate plastic pollution and develop alternatives to SUPs.

Further, to engage with and reach out to school students across the country and spread awareness about plastic pollution caused by littered SUP items, a pan-India essay writing competition for school students was also announced. Zero Circle Plastic Alternatives Pvt. Ltd, which provides seaweed-based packaging solutions and Dharaksha Eco Solutions, which specializes in packaging material made from crop stubble waste, were the winners in identifying solutions that eliminate SUPs.

61 https://law.nus.edu.sg/wp-content/uploads/2020/04/012_2019_MandyFang_Jolenelin.pdf

Chapter
6

Plastic Alternatives

As per a research study by Laurent Lebreton & Anthony Andrady, future demand (Figure 11) for plastic will nearly triple by 2060. India would become the largest mismanaged plastic waste (MPW) generating country by 2035, and the demand would reach 46.3 (38.6–52.0) MT/yr by 2060, followed by China with 33 (28.1–36.8) MT/yr.

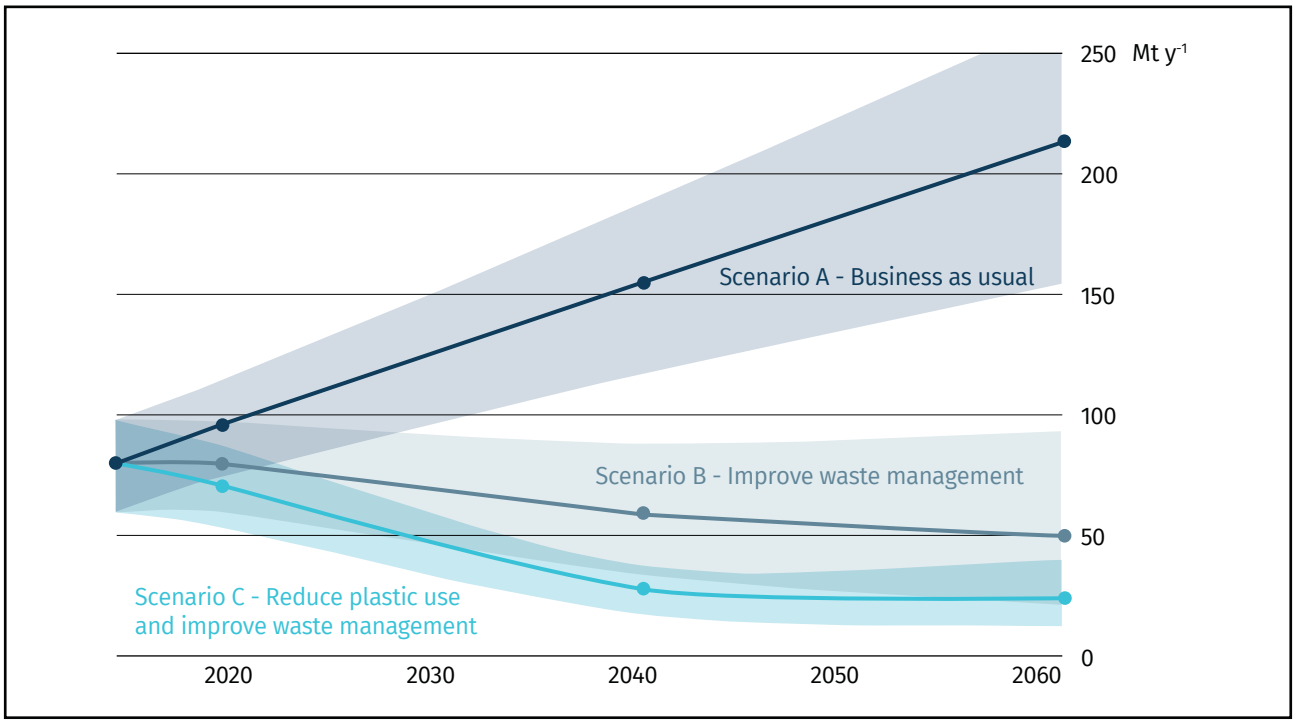


Figure 11: *Future projections of global mismanaged plastic waste generation and distribution per continent under three scenarios*

The study also draws two alternate scenarios – a) improve waste management infrastructure as per capita GDP grows and b) reduce plastic use demand per capita with a fraction of plastic in municipal solid waste capped at 10% by 2020 and 5% by 2040, waste management gradually improves as in the previous scenario.

Material	Polymer	Common biomass source	Examples of common uses	Terrestrial			Aquatic
				C-d	C-i	B	B
Cotton	Cellulose	Cotton plant (Gossypium sp.)	Clothing, other fabrics	H	H	H	H
Hemp	Cellulose	Hemp (Cannabis sativa)	Clothing, other fabrics	H	H	H	H
Flax/Linen	Cellulose	Flax/linseed (Linum usitatissimum)	Clothing, other fabrics	H	H	H	H
Jute	Cellulose & lignin	(Corchorus sp.)	Sacks, carpets, clothing, rope, other fabrics	H	H	H	H
Coir fibre	Cellulose & lignin	Coconut (outer shell)	Mats, brushes, sacking, rope, fishing nets	H	H	H	
Ramie	Cellulose	China grass (Boehmeria nivea)	Clothing, other fabrics, industrial sewing thread,	H	H	H	H
Abaca/Manila hemp	Cellulose, lignin & pectin	Banana (Musa textiliis, inedible)	Tea bags, banknotes, matting, rope	H	H	H	H
Pina	Cellulose & lignin	Pineapple leaf (Ananas comosus)	Clothing, other fabrics	H	H	H	H
Sisal		(Agave sislana)	Textiles, bags, rope, twine	H	H	H	H

Figure 12: *Natural fibres based plastic substitute*

Figure 12[62] lists a variety of common plant materials, the component polymer(s), plant source, and examples of everyday uses. It also provides a qualitative estimate of degradation properties under various terrestrial and aquatic conditions. Generally, degradation rates will be higher under warmer conditions.

Such natural fibres produced in many countries provide an essential source of income for farmers and play an important role in eradicating poverty and environmental pollution. A wide variety of natural materials are utilized to meet many of society's needs. The production of plant fibres for textiles is dominated by cotton, followed by jute and related plants and could play an important role in reducing plastic usage in India.

62 https://wedocs.unep.org/bitstream/handle/20.500.11822/25485/plastic_alternative.pdf

Some of the other sustainable alternatives that should be considered to deal with plastic waste are to use of biodegradable plastics, biodegradable bioplastics, and compostable plastics. These provide an alternative to conventional plastic usage, though often, there is confusion about the differences among the terms bioplastics, biodegradable plastics, compostable plastics, and oxo-degradable plastics[63].

1. **Bio-plastics** encompass many materials that are either bio-sourced or biodegradable or both and are made from renewable biomass resources, most often corn starch/ sugarcane/ cassava – which might be either biodegradable or not.
2. **Biodegradable plastic** means that plastics, other than compostable plastics, which undergo complete degradation by biological processes under ambient environmental (terrestrial or in water) conditions, in specified time periods, without leaving any micro plastics, or visible, distinguishable or toxic residue, which has adverse environment impacts, adhering to laid down standards of BIS and certified by CPCB.
3. **Compostable plastics** mean plastics that undergo degradation by biological processes during composting to yield CO_2, water, inorganic compounds and biomass at a rate consistent with other known compostable materials, excluding conventional petro-based plastics, and do not leave visible, distinguishable or toxic residue. These can be plant-based, but can also be petroleum-based as well. BASF's Ecoflex® is an excellent example of a compostable polymer, which is partly petroleum-based but is compostable at industrial compost facilities.
4. **Oxo-degradable/ oxydegradable/ oxo-biodegradable plastics** are conventional plastics such as PE, which include an additive to help them break down into smaller fragments, which could lead to microplastic leakage in the environment.

6.1 BIOPLASTICS/ BIODEGRADABLE PLASTICS/ COMPOSTABLE PLASTICS AND OTHER SUBSTITUTES

Bioplastics constitute about 1% (or 2.1 million metric tons) of all the plastics produced annually according to the industry association European Bioplastics. Although this represents a small fraction of plastic production, bioplastic production is expected to increase by 300,000 metric tons between 2019 and 2024. Bioplastics could address the need to reduce fossil fuel consumption however, they do not address plastic pollution, especially in marine environments.

At present, common commercially produced biodegradable bioplastics include Polylactic acid (PLA), PBAT, PBS and Poly (hydroxyalkanoates) (PHA). PBAT, PLA and their composites are the best performance and economically viable biodegradable plastics available in the market.

Biodegradable plastic

Recently, there have been emerging technologies that have developed additives, that when used in the formulation, make it possible to manufacture completely biodegradable polyolefins such as PP and PE. These biodegradable plastics are evolving as a potential alternative to conventional plastics. Biodegradable plastics are recyclable, which reduces negative environmental impacts and enhances economic sustainability. These plastics, if due to some reasons, are not picked up for

63 https://gridarendal-website-live.s3.amazonaws.com/production/documents/:s_document/554/original/UNEP-CHW-PWPWG.1-INF-4.English. pdf?1594295332

recycling, biodegrade in the ambient environment. At present, both aerobic as well as anaerobic biodegradable plastics are available.

Biotransformation process

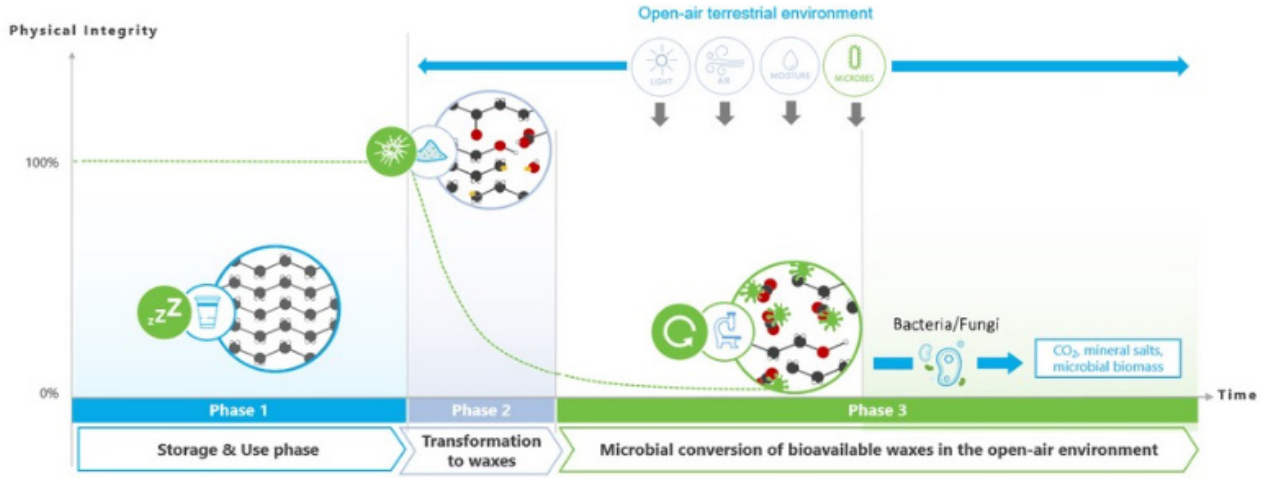


Figure 13: *Biotransformation technology process*

A UK-based company has developed an additive which, when added to the masterbatch of polyolefins, i.e., PE and PP, onsets the degradation. The plastic weathers to a biodegradable wax, a non-toxic substance on which microbes feed, leaving no microplastics. Known as the "biotransformation process", once active, it combines the effects of light, air, and moisture to create a catalytic effect that causes the polymer chains to lose over 90% of their original structure (Figure 13). The dormancy period of the technology is created by balancing the stabilizers with active ingredients to allow use, reuse, and recycling.

Polypropylene-based speciality film

A Malaysian company has developed a technology on anaerobic biodegradable PP-based speciality film and this has been tested at the Eden Research Laboratory, USA. This new PP has achieved 84% biodegradation[64]. The testing of the further improved film has been initiated in India and has shown promising results.

Biodegradable cutlery

Defence Research and Development Organisation (DRDO) Lab DFRL has developed technology for biodegradable cutlery (Figure 14). It is produced through the reinforcement of natural fiber (agro-waste) into matrix/resin, which is a polymer of renewable resources and is formed through a compression or injection process. Biodegradable tableware (spoon, fork, spork, bowl, khullad, plate, teacup) can be used as an alternative to plastic tableware as natural biopolymers offer significant benefits such as degradability, biocompatibility, and biological safety as compared to plastic that persists in the environment with environmental hazards. The biodegradable cutlery is suitable for serving hot and cold meals. Biodegradability occurs within 180 days and is compostable in 90 days in the natural environment.

64 Eden Research Laboratory, NE. Report Number: 0920171127B

Figure 14: *Biodegradable cutlery–DRDO*

A renowned industrial firm in India has developed a novel process for biodegradable plastic (TRL 6 level[65]). The developed PBAT grades showed good performance in terms of physical and mechanical properties. The developed grades are also compounded with various fillers for ease of downstream processing and enhancing product properties required for applications in flexible as well as rigid packaging and agriculture mulch films, among others.

As per the UNEP report, a cross-section of countries across the world–Europe (Italy, Greece), Africa (Benin, Cameroon, Niger), Asia (South Korea, Vietnam, Cambodia), and the Middle East (Saudi Arabia, UAE)–have encouraged biodegradable plastic bags through either bans on non-biodegradable plastic or incentives for biodegradable plastics.

Compostable plastics

Presently, over 150 compostable plastic manufacturers have been certified by CPCB, and they are manufacturing a wide range of products, including films, bags, cutlery items, straws, gloves, aprons, thermoformed products etc. The installed capacity of the compostable plastics is approximately 3,00,000 TPA, and the list of certified compostable plastics is available on the CPCB website.

DRDO & Ecolastic Products Pvt Ltd (Hyderabad) have jointly developed technology to make compostable plastics. This technology of starch-based compostable bags/films is being commercialized and it is competitive and meets the performance requirements of most short-life applications. This technology

65 RIL Integrated Annual Report-2020-21, 2019-20 & 2018-19.

for making bags, cups, plates, molded cutlery and toothbrushes, thermoformed boxes, etc., is ready and already in commercial use in places such as Tirupati for Prasadam bags.

Composting plastics requires a separate composting facility with specific environmental conditions, according to widely accepted International and Indian standards. The necessary conditions for the decomposition of compostable bags do not exist in municipal landfills. Compostable plastic packaging is not a blanket solution but rather one for specific, targeted applications[66].

6.2 GLOBAL ACTION ON PLASTIC ALTERNATIVES

Various governments across the world have come up with creative policies to mitigate the plastic threat; for instance, since 2004, the government of Luxemburg, along with Valorlux, has replaced the country's SUP bag with the Öko-Tut, an eco-sac reusable bag. This resulted in an 85% drop in plastic consumption in the first nine years of the initiative. This has cut down on the use of 1.1 billion SUP bags[67].

Costa Rica planned to eliminate plastic bags, bottles, cutlery, straws, and coffee stirrers by 2021. The objective was to replace 80% of the country's disposable plastic packaging with non-petroleum renewable materials that can biodegrade within six months, even in a marine environment. Renewable choices include cassava bags, sugar cane takeaway boxes, and wooden coffee stirrers. By 2017, the country discarded 1.5 million plastic bottles every day.

The Government of Baja California, Mexico, passed a restrictive law to reduce SUP. Alternatives in the region include straws made of agave fibers or avocado pits, cutlery made of cornstarch, Kraft paper bags, Greenware cups and containers made from plants, and hot beverage cups made of bamboo fibers and waxed with PLA, all of which are certified to be 100% compostable.

Edible Seaweed Cups

Seaweed can grow up to 60 times faster than land-based plants, making it an important carbon sink. An Indonesian company, in 2016, in response to the plastic waste crisis, made edible seaweed cups under the Ello Jello brand that come in various colours and flavours, from orange to green (Figure 15). The company also produces edible food wrapping and single-use sachets, typically used for instant coffee or food condiments.

Figure 15: *Ello Jello edible cups and packaging*

66 https://chemicals.nic.in/sites/default/files/SUP_Expert_Committee_Report.pdf

67 https://www.rd.com/list/ways-other-countries-are-replacing-plastic/

Algae-blended ethylene-vinyl acetate

A US based firm has created algae-blended ethylene-vinyl acetate transforming air and water pollution (ammonia, phosphates, and carbon dioxide) into plant biomass rich in proteins. The material called Bloom, a bouncy and flexible foam is used in the soles of most shoes (Figure 16). It replaces the incumbent material traditionally made from petroleum.

Figure 16: *Shoe products using Bloom algae foam*

Lipids and Glycerolipids Coating

Figure 17: *Time lapse images of strawberry with lipid coating*

A California based company has formulated a plant-derived (lipids and glycerolipids) edible, odourless, colourless, and tasteless coating (Figure 17). This can help in eliminating the packaging of fruits and vegetables and increasing the shelf life[68].

Zero plastic recycled paper bottle

A UK firm[69] has invented the only commercially available zero plastic recycled paper bottle in the world. From seal packing to the inner lining of the bottle, everything is made from a sustainably sourced material (Figure 18). Feasibility studies are carried out to design for each product and use across multiple industries, from pharmaceutical & cosmetics to foodstuffs & drinks and home care and cleaning products. The company was recently acquired by HP Inc.

68 https://www.apeel.com/

69 https://www.choosepackaging.co.uk/about-us

Figure 18: *Zero plastic paper packaging bottle*

Edible packaging products

London based startup has made seaweed-based sustainability packaging material that is entirely biodegradable and edible and that can be home composted in 4-6 weeks (Figure 19). So far, the packaging has been used to create thin films and coatings for cardboard, takeaway boxes, as well as sachets for condiments[70].

Figure 19: *Edible/ biodegradable packaging products*

Wood-based paper packaging

In 2020, a Scotland-based paper manufacturing company developed a sustainable wood-based alternative to plastic packaging (Figure 20). It is a translucent, functional barrier paper that preserves the quality of food and cosmetics just as well as conventional plastics while ensuring a limited impact on the environment. This pioneering paper is fully recyclable, compostable, bio-degradable, and offers a sustainable alternative to SUP packaging[71].

70 https://www.notpla.com/products-2/

71 https://sylvicta.arjowiggins.com/news/new-translucnet-barrier-paper/

Figure 20: *Translucent paper packaging*

6.3 TECHNOLOGY STATUS ON PLASTIC ALTERNATIVES WITH LIFECYCLE ASSESSMENT DEVELOPMENT

The total global production of both bio-based and biodegradable plastics in 2019 was 2.1 million tons per annum. The estimated production growth is a remarkable 14% over four years and implies that if plastic production stays constant in the next ten years, biodegradable plastics will rise to about 2% of the total plastic market. The global market for bioplastics and biopolymers is projected to reach US $14.9 Billion by 2024, registering a compounded annual growth rate (CAGR) of 15.6% over the analysis period.

Besides Poly Lactic Acid (PLA), which accounts for 24% of the global production capacity for biodegradable polymers, mainly starch blends (44%), other biodegradable polyesters, including PBS and PBAT, Ecoflex (23%) and polyhydroxyalkonates (PHAs) (6%) are being produced at industrial scale.

An average of 200-kilo tons per annum is produced per type of biodegradable plastic. This value represents approximately 0.0005% of all plastics produced every year. This small fraction demonstrates the efforts needed to displace the fossil-carbon giant in addition to the enormous market potential of biodegradable plastics.

It is estimated that, as of 2020, more than 61.6% of bioplastics are used in packaging. Due to its bio-based nature, it is predicted that Southeast Asia will see the most considerable increase in terms of production capacity[72]. This can be attributed to the agrarian economy and the agricultural residues available in Southeast Asia, that will be further utilized to produce biodegradable Bioplastics. However, the growth of bioplastics also depends on consumer demand and awareness among the people. It is also imperative to make it more affordable so that it can have a broader and better reach. Another important aspect of bioplastics is the time taken to biodegrade and place (in a household or in separate facilities). All this depends on the policies and the standards adopted by countries across the globe, which are altered according to their needs and requirements.

72 European Bioplastics e.V. Bioplastics market data. https://www.european-bioplastics.org/market/ (accessed December 8, 2021)

Current global technology and manufacturing perspectives:

A summary of bioplastic is given in Table 3 for PBAT, PBS, PLA & PHS, covering raw materials and catalyst, polymerization process, current resin manufacturers and their product trade name and Grades and their critical applications (Table 7).

Table 7: Biodegradable bio plastics

	PBAT	PBS	PLA	PHA
	Poly (butylene adipate terephthalate) [73] [74]	Poly (butylene succinate)[75]	Poly (lactic acid)[76]	Poly (hydroxyalkanoates)[77]
Raw Materials	✦ Terephthalic Acid ✦ Adipic Acid ✦ Butanediol ✦ Ti-based catalyst	✦ Succinic Acid ✦ Butanediol ✦ Ti-based catalyst	Bio-derived monomers – Lactic acid & Lactide ✦ Sugarcane to Lactic acid by the fermentation process ✦ Lactic acid to lactide by polymerization- depolymerization process	Produced by microorganisms, including through bacterial fermentation of sugars or lipids.
Process	Melt Polycondensation Polymerization	Melt Polycondensation Polymerization	Ring-Opening Polymerization (ROP) of lactide for PLA (Catalyst: Tin compound)	The polymer is obtained by extraction from a microorganism.
Manufacturers & Trade Names	✦ BASF (Germany)–Ecoflex ✦ Novamont (Italy) – Origo-Bi ✦ Xinjiang Blue Ridge (China) – Tunhe ✦ Lotte fine chemicals (S. Korea)–Enpol	✦ Mitsubishi chemical performance polymers (Japan)–BioPBS ✦ Hexing Chemical (China) ✦ Xinfu Pharmaceutical (China) ✦ Showa High Polymer – Bionolle	✦ NatureWorks (Joint-venture between Cargill (US) and PTT (Thailand) – Ingeo® Biopolymer ✦ Total-Corbion (Joint-Venture between Total (France) and Corbion (NL)	✦ Kaneka – Japan ✦ Bio-on – Italy ✦ Yield10 Bioscience

73 An overview on synthesis, properties and applications of poly (butylene-adipate-co-terephthalate)–PBAT." Advanced Industrial and Engineering Polymer Research 3(1) 19-26 (2020).

74 Poly (butylene adipate-co-terephthalate) Polyester Synthesis Process and Product Development; Polymer Science, Series C volume 63, 102–111(2021)

75 Synthesis and properties of poly (butylene succinate): Efficiency of different transesterification catalysts. Journal of Polymer Science Part A: Polymer Chemistry. 49(24),5301-12(2011)

76 Synthesis and Biological Application of Polylactic Acid, Molecules 25, 5023 (2020)

77 Bacterial Production of Hydroxyalkanoates (PHA); Universal Journal of Microbiology Research 4(1), 23-30 (2016)

	PBAT	PBS	PLA	PHA
Grades & Applications	✦ Ecovio® F2331–BASF (ecoflex® F & PLA) ✦ This grade possesses high melt strength, good thermostability up to 230°C and good mechanical properties. It is used for the manufacturing of packaging films, hygienic films and carrier bags. ✦ Ecovio® M2351 – BASF (ecoflex® F & PLA) ✦ This is suitable for producing black, transparent and coloured mulch films. ✦ Ecovio® T2308–BASF (ecoflex® F & PLA) ✦ It is a thermoformable version for food trays and cups. ✦ Ecovio® IA1652 BASF (ecoflex® F & PLA) ✦ Mineral filler & PLA in high content. For injection moulding. This grade is a printable, sealable and easy to colour compound	✦ BioPBS™ FD92–Mitsubishi chemical ✦ Paper coatings, sealants in flexible packaging, hot beverage cups, boxes and utensils for freshly cooked food.	✦ Ingeo® Biopolymer 6204D – NatureWorks Thermoplastic fibre-grade resin Potential applications include woven & knitted 100% continuous filament apparel, intimate staple blend fabrics including blends with cotton, wool, other fibres, woven and knitted fabrics, netting for civil engineering applications as well as home furnishing ✦ Ingeo™ Biopolymer 4032D–NatureWorks For lamination and other packaging applications. It provides a barrier to flavour, grease and oil resistance ✦ Ingeo™ Biopolymer 2500HP-NatureWorks FDA approved, so this may therefore be also used in food packaging, a high-viscosity PLA for extrusion applications ✦ PLA Blend A -Total Corbion It possesses heat resistance like PP, PS and ABS. For Blend A the PLA homopolymers	✦ Ecomp® 142–Kafrit group ✦ Biode-gradable polyhydroxy-alkanoate (PHA)-based compound, used for film appli-cations such as shopping bags. ✦ Ecomp® 420–Kafrit group ✦ Biode-gradable starch-based polyhydroxy-alkanoate (PHA) com-pound. Used to produce twin-wall sheets of 4 mm

	PBAT	PBS	PLA	PHA
			have been nucleated with a small amount of PDLA homopolymers and a traditional nucleant, used in injection moulding applications, recommended for bioplastic products, consumer electronics, high heat packaging, automotive interiors, apparel and many more. ✦ PLA Blend B-Total Corbion In Blend B, talc is added to Blend A for higher temperature resistance. Used in injection moulding applications. Recommended for bioplastic products, consumer electronics, high heat packaging, automotive interiors, apparel and many more ✦ PLA Blend C-Total Corbion PLA Blend C by Total Corbion PLA is the impact modified version of Blend A. Used in injection moulding applications	

Status of biodegradable resin and monomers manufacturing in India:

Currently, there is no manufacturer of essential synthetic biodegradable plastics (PBAT, PBS, PLA & PHA) in India. Hence, there is an immediate need for commercial manufacturing not only for resin but also for monomers to cater to the demand for biodegradable plastics on a sustainable basis as an alternative to current resin for SUP applications. This is a manufacturing area critical for the uninterrupted and economical supply of raw materials to resin manufacturers and resin supply to product manufacturers.

6.4 TECHNOLOGY READINESS LEVEL (TRL) MAPPING OF PRODUCTS–GLOBAL AND INDIA

The current bio-PET production only includes 32% of bio-derived Monoethylene Glycol (MEG), while the remaining 68% is fossil-carbon-derived TPA. The disadvantage of biomass as a precursor consists of its highly oxygenated nature biomass that will hinder the synthesis of linear alkyl plastics (e.g., bio-PE).

New methods have also evolved to minimize the use of such compounds and move towards greener compounds that are biodegradable and non-toxic. Such compounds in this context are known as Deep Eutectic Solvent (DES), which is a combination of two or more solids that form, through hydrogen bond formation, a eutectic liquid mixture at a temperature lower than the melting point of each compound that is part of the DES[78]. DESs popularly used in this process are Choline Chloride: Urea, Choline Chloride: Oxalic acid, Potassium Carbonate: Glycerol.

In the case of DES, the cellulosic and lignin part is utilized in the production of bioplastic, which is biodegradable. Similarly, in the case of paper plates, dissolved lignin can be obtained from DES, and the subsequent lignin can be used as a replacement for binders in concenters, a soil conditioner, as a filler, or as an active ingredient of phenolic resins, and as an adhesive for linoleum[79]. DES can be reused again for the same purpose.

In recent years, a large number of researchers have been attracted to synthesizing biodegradable polymers that could substitute commercially available polyolefins, which are readily utilized as SUPs, particularly in food-contact articles.

Global themes like sustainable growth and circular economy focus on replacing petro-based products with bio-based renewable products, recycling non-biodegradable products, cleaner and greener processes to produce commodity products, and replacing hazardous chemicals with safer alternatives. One such specific area of concern is to replace conventional plastics with bioplastic, which in turn will reduce pollution and also pay the way for creating wealth out of waste. However, transforming the theoretical possibility into market-ready products that are priced affordably is the biggest hurdle being faced by companies so far.

The key metric used to assess the maturity of these evolving technologies related to each bio-based product is the TRL. It provides us with an idea of how long it took to be commercially viable from its conceptualization stage.

78 Ramón D. J., and Guillena G. Deep eutectic solvents: Synthesis, properties, and applications, 2019, 1–370. https://doi.org/10.1002/9783527818488

79 American Institute of Chemical Engineers. Lignin for sustainable industrial uses. AIChE Annual Meeting, 2017. https://www.aiche.org/conferences/aiche-annual-meeting/2017/proceeding/session/lignin-sustainable-industrial-uses (accessed December 8, 2021).

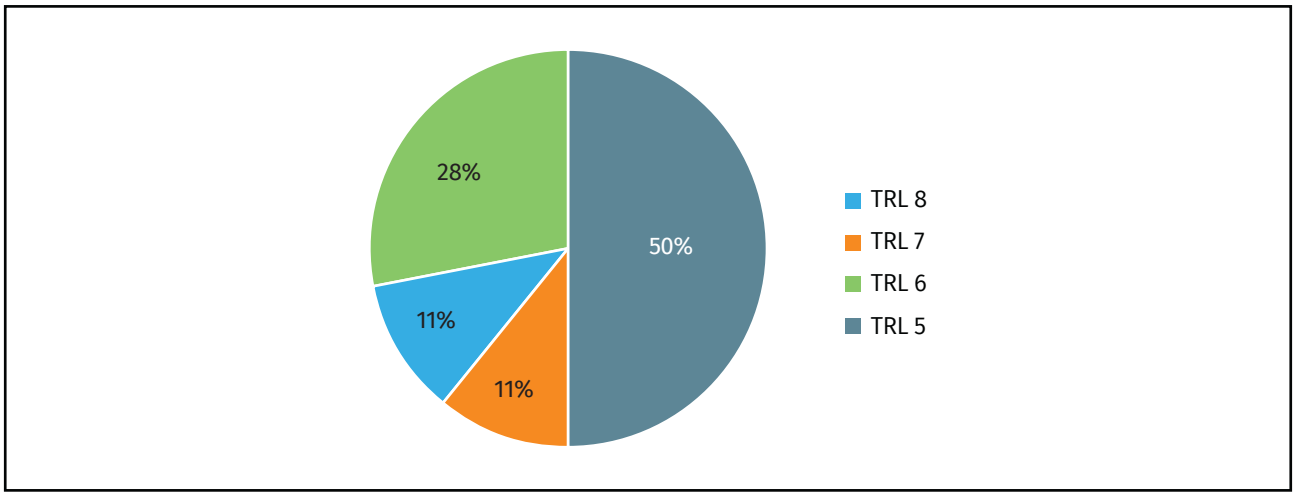


Figure 21: *TRL distribution for the emerging bio-based products*

Figure 21 shows that half of the products are under development and are currently being tested in laboratory conditions that mimic relevant environmental conditions, and very few have managed to upscale their technologies where mass production is possible. A TRL of 4-5 is shown for technologies based on second-generation feedstock, compared to a level of 8-9 for first-generation feedstock.

i. R&D efforts–Global Institutions

The two varieties of plastics available and researched today are bio-based plastics and biodegradable plastics. SUP is a major environmental concern world over, and there is a continuing interest in the area of bioplastics and also in developing an alternative solution for reducing plastic pollution and carbon footprints. Utilizing agro wastes/ agro-residues for making value-added products as an alternative to plastic use in many fields is progressing and thereby achieving circular economy outcomes.

c. A novel food packaging material based on biodegradable PCL/Ag-kaolinite nanocomposites[80] developed by the University of Science and Technology, Houari Boumediene, Algeria (Prof. A. S. Hadj-Hamou & team)

d. Biodegradable polymer nanofibers possessing a special property of slow-release-system which could be utilized in several agri-food applications[81], developed by the Center for Exact Sciences and Technology (Dept. of Chemistry) at Federal University of São Carlos (UFSCar), São Carlos, Brazil (Prof. Daniel S. Correa & team) have recently developed.

e. A state-of-art review on recent progress in the field of Nanobiotechnology, particularly in the Food Packaging applications[82] developed by the University of Waikato, Hamilton, New Zealand (Prof. Aydin Berenjian & team) reported.

80 Benhacine F., Ouargli A., and Hadj-Hamou A. S. Preparation and characterization of novel food packaging materials based on biodegradable PCL/Ag-kaolinite nanocomposites with controlled release properties. Polymer-Plastics Technology and Materials, 2019, 58: 3, 328-340. https://doi.org/10.1080/03602559.2018.1471714

81 Martins D., Scagion V.P., Schneider R., Lemos A.C.C., Oliveira J., and Correa D.S. (2019) Biodegradable polymer nanofibers applied in slow release systems for agri-food applications. In: Gutiérrez T. (eds) Polymers for agri-food applications. Springer, Cham. pp. 291-316. https://doi.org/10.1007/978-3-030-19416-1_15

82 Jafarizadeh-Malmiri H., Sayyar Z., Anarjan N., and Berenjian A. (2019) Nanobiotechnology in food packaging. In: Nanobiotechnology in food: Concepts, applications and perspectives. Springer, Cham. pp. 69-79. https://doi.org/10.1007/978-3-030-05846-3_5

f. The degradation mechanisms, as well as recycling of various films, were developed using biodegradable polymers[83] reviewed by the University of Palermo, Italy (Prof. Andrea Maio & team at the Dept of Engineering).

g. Studies from ETH Zürich, Switzerland, have shown that microbes can use films made from PBAT as food. They used the carbon from the polymer to generate energy and also to form biomass. It implies that PBAT biologically degrades in the soil and does not remain there as microplastic as PE does.

ii. R&D efforts – Global Industry

a. A recent development is polyethene furanoate (PEF) by the Dutch company Avantium, which is proving to be a high-performing bio-plastic.

b. Cereplast has successfully commercialized an injection-moulding grade of algae-based bioplastics–Biopropylene 109D, which is made with 20% post-industrial algae biomatter and targets thin-walled applications[84].

c. Mango Materials (USA) is a biotech start-up that converts methane to plastic by feeding methane to bacteria, which makes a biodegradable polymer.

d. Floreon Transforming Packaging (UK) manufactures high-performance bioplastics from biodegradable ingredients.

e. Vericool (USA) filed a patent application for a shipping container whose insulating material is compostable.

f. Grow Plastics (USA) has recently been given an NSF grant for its work on high-performance biodegradable sandwich core structures.

Table 8 below provides a list of global companies or manufacturers engaged in manufacturing bio-based or biodegradable polymers and their products. The TRL mapping mentioned below is based on the information available with TIFAC. The time to reach level 8 or 9 is considerable for many of the above-mentioned companies and it may take on an average ten years from the time R&D begins. Along with this time, significant investments were made into such companies by angel investors or government funding.

Table 8: List of global manufacturers of bio-based/ biodegradable polymers and their products

Sl. No.	Company Name	Product/ Technology	Biodegradability or Compostability conditions	Applications
1	Novamont (Italy) TRL-9	Starch blends (Mater-Bi®); Bio-Lubricants (Matrol-Bi)	Industrial	Mater-Bi are for films for carry bags, waste bags, extruded and moulded articles for food service, coating on paper & other substrates.

83 Scaffaro R., Maio A., Sutera F., Gulino E. F., and Morreale M. Degradation and recycling of films based on biodegradable polymers: A short review. Polymers, 2019, 11:4, 651. https://doi.org/10.3390/polym11040651

84 Filiciotto L .and Rothenberg G. Biodegradable plastics: Standards, policies, and impacts. Chem Sus Chem, 2021 , 14, 56. https://doi.org/10.1002/cssc.202002044

Sl. No.	Company Name	Product/ Technology	Biodegradability or Compostability conditions	Applications
2	Synbera Technology (Netherlands) TRL -9	Sugarcane Synterra®PLA	Industrial	coloured disposable cutlery
3	Biotrem (Poland) TRL -9	Wheat bran based		Tableware and cutlery production
4	CelluComp Ltd (Scotland) TRL -8	Beet Pulp Microfibrillated cellulose Curran®,		Granules form to use in paints & coatings
5	Paptic Oy (Finland) TRL-9	Wood pulp Paptic®	Industrial	packaging material, bags and pouches, food packaging
6	Trifilon AB (Sweden) TRL -8	Hemp Fibers	Industrial	Outdoor furniture–biobased and recycled materials.
7	Greengran BV (Germany) TRL -5	Plant Fibers		natural fibre reinforced polymer granules, bio-based matrix compounds (PLA & PHB) bio-degradable
8	BASF (GER)	Ecoflex® (PBAT), Ecoflex blends with PLA (Ecovio®) and other materials such as starch	Industrial, Home and Soil	Shrink film, Organic waste bags, Fruits & Vegetable bags, Mulch films, Moulded & thermoformed products, Paper coating
9	Bewi	PLA based Foam (BioFoam®) which is recyclable and compostable	Industrial	Filling hollow spaces like Beanbags and Pillows and for shape moulding replacing EPS (as in protective pkg.)
10	Biome Technologies (UK)	Potato & Corn starch-based resins	Industrial & Home	Films for food & industrial packaging, shopper bags, waste bags; Coating on paper, flexible films, moulded goods, extruded sheets, and food wraps, etc.
11	Biomer (GER)	PHB (Biomer®)	Industrial & Home	-
12	Biotec (GER)	PLA and Starch blends (BIOPLAST)	Industrial & Home	Films for carry bags, waste bags and Injection moulded articles for food pkg.

Sl. No.	Company Name	Product/ Technology	Biodegradability or Compostability conditions	Applications
13	Braskem (Brazil)	Bio-based PE, EVA and PE Wax (I'm green™) from sugarcane/ ethanol	Recyclable as conventional PE	For consumer goods packaging and similar applications
14	Danimer Scientific	PHAs (Nodax™) and their blends	Industrial, Home and Soil	Food & Vegetable bags, Carry bags, Waste bags, cups, lids, straws, plates and diaper linings etc.
15	DSM (Geleen, NL)	Polyamide-4.10 (EcoPaXX®), Copolyester (Arnitel® Eco)	Recyclable	Automotive, consumer goods and food contact applications
16	Ecomann (China)	PHA (Ecomann®) & wood powder composites with PHA based bags & 3D printer filament	Industrial & Home	For food & vegetable storage, Waste storage, & 3D printing
17	FKuR (Willich, GER)	PLA blends (BioFlex®), Cellulose acetate (Biograde®), Bio-PE (Terralene® = I'm green of Braskem), Fibre-filled PLA materials (Fibrolon®)	Industrial & Home	Bioflex is for household, agricultural and hygiene films. These are also food contact compliant.
18	Futerro	Lactide and PLA from vegetable resources (lactic acid sourced from Galactic)	Industrial	Blown & Cast films for food packaging, labels, and laminated films
19	Futumura (UK) (Former Innovia)	Cellulose films (Cellophane® & Natureflex®)	Natureflex®: Industrial & Home compostable	Fruit & Veg bags, Bio-waste bags, Over wraps, Coffee capsules, Catering items and other food packaging. Can replace BOPET and BOPA in barrier laminates
20	Huhtamaki Group	PLA based food trays, cups, lids and trays (Bioware®)	Industrial	For food storage applications
21	Kaneka Biopolymer (US)	PHBH	Industrial & Home	Food & Vegetable bags, Carry bags, Waste bags, etc.
22	Mirel Bioplastic by Telles (US) Former Metabolix	PHA (Mirel™)	Industrial & Home	Film grades for mulch film, compost bags, retail bags and packaging. Moulding & thermoforming grades are also available

Sl. No.	Company Name	Product/ Technology	Biodegradability or Compostability conditions	Applications
23	Mitsubishi Chemical Europe (GER) and PTT MCC Biochem (Thailand)	Biobased PBS (BioPBS™) Petro based PBS (GS Pla®)	At ambient (30 °C) and Industrial	As sealant layer in flexible packaging & coating on Paper because of Elution resistance to oils, Heat sealability and printability. It can be blended with other biopolymers.
24	NatureWorks (Naarden, NL)	PLA (Ingeo™) from plants (Sugarcane, cassava, Corn or beets)	100% Ingeo is Industrial compostable	Multiple applications like food packaging, 3D printing, floor & wall coverings, agriculture.
25	Plantic Technologies (Jena, GER)	Hydroxypropylated, high amylose starch-based products (Plantic™ HP & Plantic™)	Plantic HP is home compostable; Recyclable	For use in food packaging as heat sealable and barrier layer.
26	Rodenburg (Oosterhout, NL)	Potato Starch blends (Solanyl®)	Industrial & Soil	Sanitary napkins, Flower pots and others
27	RWDC	PHA (Solon)	Industrial & Home	Straws, cups, lids, trays, food containers and bags
28	Tepha (US)	Tephaflex® (P4HB)	Degrades in the body into 4HB, which metabolizes by the body itself	Medical devices such as sutures, Mesh and films.
29	TGBM (China)	PHA (Sogreen)	Industrial & Home	Blown & Cast films for food packaging, wrapping and other film products. Foamed, Sheet and injection moulded products can also be made.
30	Tianan Biologic materials (China)	PHBV (ENMAT™)	Industrial & Home	Blown films, Extrusion & Thermoforming and Injection moulding
31	Toray Industries	Bio-based PET (Partial) 100% BioPET is under-development	-	Fiber & Textiles, Films & Resin
32	Total Corbion (Gorinche, NL)	PLA compounds (Luminy®)	Industrial	Food Packaging, Food-wares, Non-wovens and 3D printing

Sl. No.	Company Name	Product/ Technology	Biodegradability or Compostability conditions	Applications
33	Toyobo Co. Ltd.	Packaging films based on Biobased PEF (Polyethylene Furanoate)	Recyclable	Food Packaging, Display films in electronics, Industrial & medical packaging
34	Zhejiang Hisun Biomaterials (China)	Plant based PLA (REVODE)	Industrial	BOPLA film and injection moulding & blow moulding applications

iii. R&D Efforts – Indian Institutions

- **CSIR-National Institute of Interdisciplinary Science & Technology**

a. **Alternative to single-use tableware and cutlery**: Process knowhow for making biodegradable tableware and cutlery from various agro-residues (TRL–7)

The institute has demonstrated lab-scale production of biodegradable products (like plates, cups, bowls, cutleries, straws etc.) using a wide range of agro residues (rice bran, rice husk, rice straw, wheat wastes, sugarcane bagasse, fruit peels, apple prunes etc.). The knowhow has been transferred to three firms. Commercial production was started by one firm.

The knowhow for production of biodegradable tableware like plates, cups, bowls, cutleries, straws etc. from different types of agro-residues developed by the Council for Scientific and Industrial Research–National Institute for Interdisciplinary Science and Technology (CSIR-NIIST) can be tailor-made as per client requirements in manual, semi-automatic & fully automatic modes to process 100-200kg, 200-500 kg or up to 2000 kg raw material per day respectively. The product cost and quantity depend on the raw material and type of automation. For example, the average price of a plate of 10-inch diameter will be approximately 1.0 to 1.5 rupees, weighting around 40-50 grams.

b. **Biobased and biodegradable resin-coated paper for food packaging with repulpable potential (TRL – 5)**

In this invention of paper-based food packaging, a low-cost, abundantly available and solvent-free industrially viable coating method with repulpability potential has been adopted using functionalized non-edible plant oil derivatives as an alternate to a plastic liner (Figure 22).

Structural morphology, thermal stability, WVTR, contact angle and mechanical properties have been found to be suitable for paper-based packaging. Importantly, repulpability or recyclability of paper has been explored, confirming the path towards circular principles. The coating also showed compatibility with fatty food as per USFDA 176.170 standard for paper and paper board.

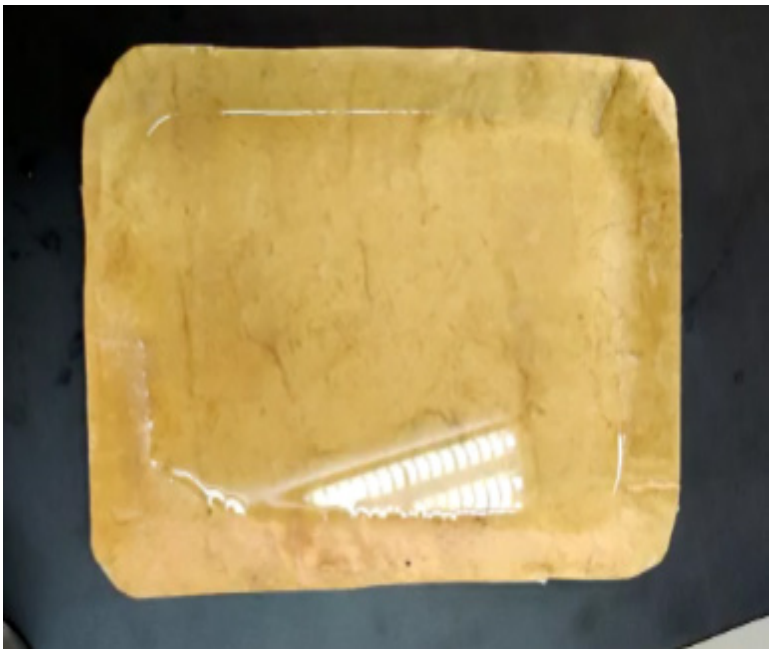


Figure 22: *Water Retention (> 2 hrs) in coated Pineapple leaf paper plate*

The technology is a unique, indigenously developed and commercialized bio-based solution for an alternative to SUPs to replace non-biodegradable PE films. Companies like ITC, Bangalore and M/s Varsya Eco Solutions Pvt. Ltd., Trivandrum showed their interest in scaling up the process and commercializing the product. M/s Varsya Eco solutions Pvt. Ltd., Kochi, M/S Marikar Green Earth Pvt. Ltd., Trivandrum and Zero Plast Lab, NCL Innovation Park, Pune have also expressed their interest in supporting the technologies or process know-how for commercialization of the coatings.

c. **Alternative to SUP mulch films: Process knowhow for the fabrication of thinner, bio-degradable ligno-cellulosic fibre (coir, jute etc.) based mulch mats for agriculture and horticulture (TRL – 5)**

Process knowhow for the fabrication of thinner, biodegradable mulch mats using ligno-cellulosic fibres (e.g. coir, jute etc.) hot pressed with a bio-based polymer binder. Mulch is a covering, usually made of petroleum-based plastics, laid on the ground around plants to prevent excessive evaporation or erosion, inhibit weed growth, enrich soil conditions, support drip-irrigation, etc., for better crop growth. Currently used plastic mulch films are made of petroleum-based plastics (PE) that provide advantages such as being lightweight and low cost. However, the removal and disposal of this plastic mulch is a serious concern as it deteriorates upon sun exposure and environmental degradation. Additionally, the plant roots may suffocate and rot because it is not porous.

A semi-automatic pilot-scale facility for the demonstration and fabrication of biodegradable mulching mats and sheets is available at CSIR-NIIST. The process is sustainable by utilizing local resources and there is high-value addition to any plant fibres (waste fibres/baby fibres). These mulch mats are biodegradable and eco-friendly substitutes for SUP mulching films, thinner, flexible, rollable and have low water absorption; compared to latex-based mulching mats, they have a longer service-life, breathability and support drip-irrigation add value to the soil upon degradation.

Indian Institute of Science (IISc), Bangalore, has developed (TRL–5) a substitute for SUPs manufactured by concocting cellulose extracts and non-edible oils extracted from agricultural stubble. This alternative to SUP is biodegradable, non-toxic, and leak-proof. The extracts from the agricultural stubble are mixed with di-isocyanate compounds and toluene. This mixture solution undergoes 8-hour heating and 12-hour cooling, which generates polyurethane sheets (PUs). These sheets are malleable enough to be developed into cutlery, containers, and carry bags.

- **CIPET: School for Advanced Research in Petrochemicals (SARP)-LARPM**

  a. **Synthesis of bio-derived PUs (TRL-5)**

  The institute has developed biodegradable mulching film employing renewable resource-based materials, such as modified functionalized thermoplastic starch, natural fillers, and sustained release nanoscale fertilizers HALS for weed control and soil temperature control, disinfection before sowing as well as improved crop quality. Currently, petroleum-based plastic mulching films have concerns that include post-harvesting, which can be resolved using these alternatives.

- **IIT Guwahati and Indian Institute of Science**

  a. **Synthesis of bio-derived PUs (TRL-5)**

  Castor oil (CO) was used to derive PUs. The PUs was prepared by the one-pot reaction method (Figure 23). The stubble extracted cellulose was mixed with CO and diisocyanates such as diphenylmethane-4-4'-diisocyanate and hexamethylene diisocyanate in a toluene solvent. The laboratory work was scompleted and a sample was sent for testing to the Central Institute of Petrochemicals Engineering & Technology (CIPET). A provisional patent was filed with this discovery.

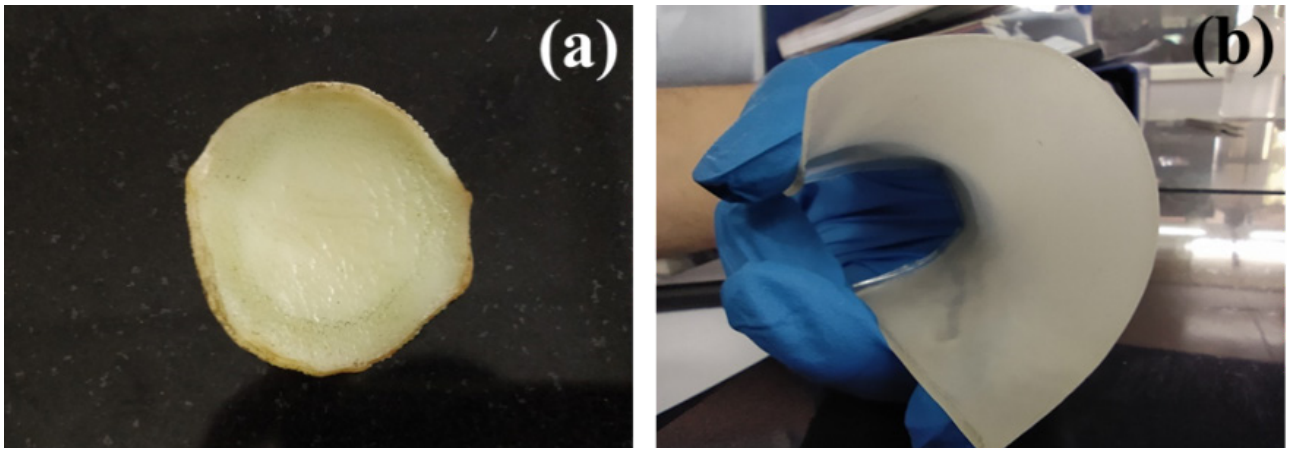


Figure 23: *Images of CO derived (a) rigid and (b) flexible PUs*

  b. **Synthesis of cellulose nano-fibre reinforced PUs using linseed oil and jojoba oil with isocyanates and cellulose nano-fibre (TRL 2-3)**

  IISc and IIT Guwahati have developed this technology for the synthesis of cellulose nano-fibre reinforced PUs. The deliverables include synthesis of amide diols from castor oil and alkyl diamine via the amminolysis route, synthesis of castor oil cellulose nano-fibre PU from amide diols, synthesis of poly-ol linseed oil and jojoba oil via epoxidation route; synthesis of linseed and jojoba oil cellulose nano-fibre PU.

- **IIT Bombay**

  a. **Lukewarm water-soluble plastic made up of agricultural waste (TRL – 4)**

  Non-biodegradable plastic bags, which are currently used in the market, are mainly composed of high-density polyethene or HDPE. These non-biodegradable plastic bags accumulate in the soil and water, thus, pollute the soil and affect natural habitats. These non-biodegradable plastics not only pose a hazard to the environment but, also to mankind by causing a number of health anomalies. The institute has designed a starch-based (cassava tubers) bioplastic which can get easily solubilized in lukewarm water and discarded easily. Various agricultural wastes were used to produce this bioplastic. The biodegradable plastic design has improved strength, elasticity, tensile strength and also no in-vivo toxic effects.

- **Indian Plywood Industries Research & Training Institute (IPIRTI)**

  a. **Utilization of recycled waste plastic material for the Development of Plastic Bonded Mat Board and Plastic Bonded Plywood (TRL – 4)**

  Institute has worked on recycling waste plastic materials, particularly milk pouches and similar kinds of materials, as an alternative to the adhesives (Phenol-Formaldehyde/ Urea Formaldehyde) of plywood and bamboo mat-based moulded products. The project was initiated in 2021, and essential trials of bamboo and plywood laminates were carried out on a laboratory scale. This could provide an opportunity to use waste plastic for high-end applications and may help address various environmental targets within SDGs.

- **K J Somaiya College of Engineering**

  a. **Isolation of cellulose from paddy straw using Deep Eutectic Solvents (TRL – 4)**

  This research would enable us to get value-added products related to rice straw with some simple methods. Upscaling of the process is underway.

  b. **Biodegradable plates (TRL – 2)**

  Paddy straw pulp will be used to make biodegradable paper plates. A compression and trimming machine will also be used to make the paper plates suitable for usage for shape and design.

- **Indian Association for the Cultivation of Science**

  a. **Supramolecular engineering in biodegradable polymers by directional halogen-bonding interactions (TRL 2-3)**

  IACS has focused on developing new, one-pot synthetic methodologies from readily available starting materials for preparing biodegradable polymers with clickable surface functionalities, stimuli-responsive properties, tailorable thermal (glass transition/ melting temperature), mechanical (tensile strength, elongation etc.) and crystallization properties to produce next-generation sustainable, biodegradable commodity plastics. In parallel, noncovalent synthetic routes are being explored to regulate the existing properties of conventional PLA. Preliminary results suggest that such dual synthetic approaches (covalent and noncovalent) to tackle these fundamental issues with PLA have great potential for designing new target-specific sustainable polymeric materials.

b. **New synthetic routes for polyesters (TRL 2-3)**

The institute is engaged in developing a new synthetic methodology involving functional group tolerant, mild and environment-friendly reaction conditions. Preliminary results suggest polyester can be made easily by such new methods utilizing already known textbook reported organic reactions, which allow structural precision, end-group functionalization, and structural diversity. Such fundamental studies may have future potential for the synthesis of new, easily degradable polyesters and related products with commercial values.

c. **Foldable polyurethanes (TRL 2-3)**

The institute is engaged in the synthesis of new biodegradable PU with promising antibacterial activity by a less specific membrane disruption pathway (in contrast to small-molecule antibiotics) similar to host defence peptides (HDPs), which are part of the innate immune system and less susceptible to developing drug resistance. PUs are another well-known biodegradable polymer with excellent potential for diverse applications, including in biology. Scalable synthesis and structural manipulation of biodegradable PUs for further improving their antimicrobial activity, testing potency against drug resistance bacteria, bacterial biofilm, in vivo studies and identifying a lead candidate for a clinical trial are underway.

- **Indian CSIR-Central Salt and Marine Research Institute**

a. **Biodegradable thin films from seaweed polymers for packaging and other potential applications (Figure 24)**

Institute has prepared biodegradable films from semi-refined k-carrageenan (SRC), refined k-carrageenan, agar, alginate obtainable from seaweed biomass, which is widely cultivated, commercially available in the national and international market (Approx. price of seaweed is $1-2 /Kg and seaweed polymers are $10-20 /Kg).

The homogeneous aqueous solution of seaweed polymer (e.g. SRC/RC/Agar/Alginate) was prepared, and these are stable at ambient conditions for 1-2 years without any degradation. It does not attract moisture at room temperature, making it suitable as active biodegradable packaging material for packaging fruits, vegetables, perishable items, etc. These films can be heat sealed, and pouches to store non-aqueous solvents can be prepared.

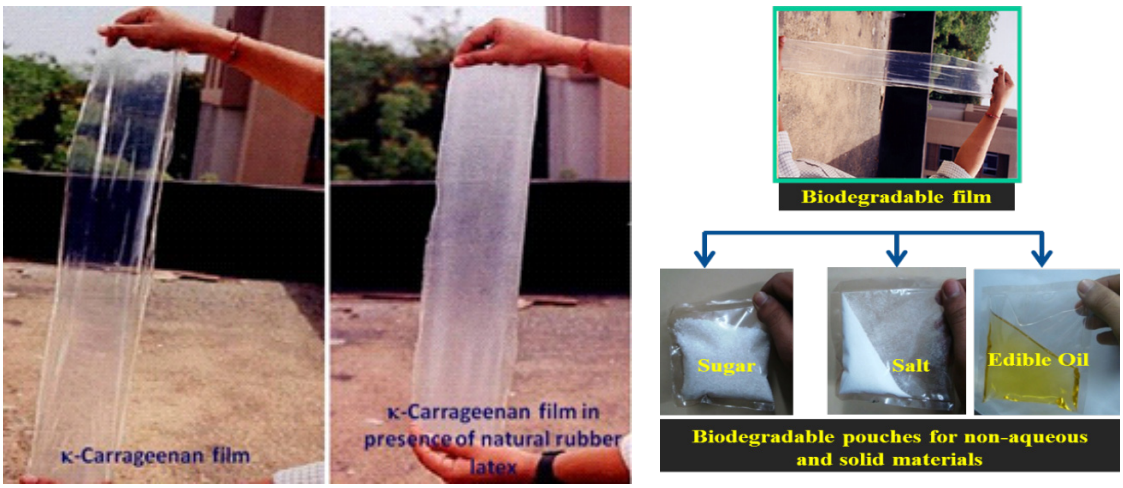


Figure 24: *Technology development by CSIR-CSMCRI*

- **Indian Institute of Food Processing Technology**

  b. **Development of biodegradable tableware (including plates) by using mango seed shells as the base material**[85]

  The institute is actively working towards the development of biodegradable tableware (including plates) by using mango seed shells as the base material. The main objective of this study is to fabricate and evaluate the properties of tableware made from mango seed shell reinforced bio-composite. The composite was fabricated using corn starch with 0, 10, 20, 30 and 40 % weight of mango seed shell powder. The experimental results found that 30% weight of the mango seed shell is the most suitable composition for developing the mango seed shell plates, and the developed bio-composite can be used as tableware like plates, trays and containers.

- **University of Calcutta**

  a. **Biopolymer derived from recycled plastic waste for tissue engineering application**

  The institute has developed bis(hydroxyethylene) terephthalate (BHET)-based novel biopolymer (polyester) for tissue engineering application[86].

  b. **Development of a series of biopolymers from PET waste**[87],[88]

  The institute is working on the development of biopolymers from electronic polycarbonate waste for tissue regeneration applications. To date, the lab has performed in vitro studies, and the results are interesting. The animal study is going on. If the polymer shows a similar effect in vivo study, then the biopolymers can be used for tissue engineering applications to regenerate various tissues like bone, cartilage and interfacial tissue, which become damaged from arthritis.

- **ICAR – Centre Institute for Research on Cotton Technology**

  c. **Biopolymer derived from recycled plastic waste for tissue engineering application**[89]

  It has recently reported a breakthrough enhancement in the tensile strength of biodegradable starch film by the incorporation of bacteriocin immobilized crystalline nanocellulose.

- **Tezpur University**

  a. **Developed biodegradable packaging films through the valorization of pumpkin seeds and peels**[90]

85 Muthu R. K., Anand T., Vidyalakshmi R., and Anandakumar S. Fabrication and property evaluation of biodegradable tableware (Plate) made from mango seed shell. Int. J. Pure App. Biosci. 2019, 7:1, 448-454. http://dx.doi.org/10.18782/2320-7051.7443

86 Sarkar K., Meka S. R. K., Bagchi A., Krishna N. S., Ramachandra S. G., Madras G., and Chatterjee K. Polyester derived from recycled poly(ethylene terephthalate) waste for regenerative medicine. **RSC Adv.**, 2014, **4**, 58805-58815. https://doi.org/10.1039/C4RA09560J

87 Ghosal K., and Sarkar K. Poly(ester amide) derived from municipal polyethylene terephthalate waste guided stem cells for osteogenesis. New J. Chem. 2019, 43, 14166-14178. https://doi.org/10.1039/C9NJ02940K

88 Ghosal K., Bhattacharjee U., and Sarkar K. Facile green synthesis of bioresorbable polyester from soybean oil and recycled plastic waste for osteochondral tissue regeneration. Eur. Polym. J. 2020, 122, 109338. https://doi.org/10.1016/j.eurpolymj.2019.109338

89 Bagde P., and Nadanathangam V. Mechanical, antibacterial and biodegradable properties of starch film containing bacteriocin immobilized crystalline nanocellulose. Carbohydr Polym. 2019, 222:115021. https://doi.org/10.1016/j.carbpol.2019.115021

90 Lalnunthari C., Monika Devi L., Amami E., and Badwaik L. S. Valorisation of pumpkin seeds and peels into biodegradable packaging films. Food Bioprod. Process. 2019, 118, 58-66. https://doi.org/10.1016/j.fbp.2019.08.015

It has recently developed biodegradable packaging films through the valorization of pumpkin seeds and peels.

- **Anna University**

  b. **Synthesis of PU from mahua oil and subsequently fabricated PU/(CS)/ nano ZnO composite film for biodegradable food packaging applications**[91]

  The institute has recently synthesized PU from mahua oil and subsequently fabricated PU/(CS)/ nano ZnO composite film for biodegradable food packaging applications.

- **National Institute of Ocean Technology**

  a. **To develop different seaweed polymers for biodegradability and bioplastics**

  NIOT has teamed up with a bioplastics manufacturing company to develop different seaweed polymers for biodegradability and bioplastics. Seaweeds were collected from the Gulf of Mannar region for bioplastic film production with the plasticizer PEG-3000 to achieve higher tensile strength. PEG is widely used in medical applications, and it is an eco-friendly plasticizer, mainly used to increase the thermos-plasticity of the polymer. The study suggests that commercial manufacturing of bio-plastics from these seaweeds would be a game-changer in the coming times.

- **IIT Guwahati**

  Institute has ready technology for the commercialization of biodegradable plastics, especially in the area of PLA, PCL, PHB and its copolymers and composites for commodity applications and medical applications.

  The Centre of Excellence for Sustainable Polymers (CoE SusPol) has been established at the Indian Institute of Technology Guwahati through the support of the Department of Chemicals and Petrochemicals (DCPC), Ministry of Chemical and Fertilizers, Government of India with the mandate to develop biodegradable plastics and related products for use in Indian industry.

  The centre has also developed technologies for the synthesis of biodegradable polymers and nanocomposites with excellent properties that are capable of overcoming the limitations of currently available biodegradable polymers on the shelf (to be tested as per Indian Standards).

Table 9: Polymer Production capabilities to be extended to the industries

Bioplastics	Possibilities for Industrialization	Composability Status	Technology Ready Level
Polylactic acid (PLA)	PLA is being imported in India	Slow compostable at soil condition, IIT G have optimized even for compostable soil conditions	100 kg PLA plant Technology ready for commercialization

91 Saral Sarojini K., Indumathi M. P., and Rajarajeswari G. R. Mahua oil-based polyurethane/chitosan/nano ZnO composite films for biodegradable food packaging applications. Int. J. Biol. Macromol. 2019, 124, 163-174. https://doi.org/10.1016/j.ijbiomac.2018.11.195

Bioplastics	Possibilities for Industrialization	Composability Status	Technology Ready Level
Polyhydroxyalkanoates (PHAs)	Good potential for rigid plastic product need to develop new indigenous technology to catch market	Compostable and biodegrade in all environments	Waste lignocellulosic biomass and various grass-based juices for PHAs production Technology ready for pilot-scale production
Polycaprolactone (PCL)	Bio-based technology can be used for the production of com-postable bagspilot	Compostable at soil condition	Production of PCL technology ready for commercialization scale 25 kg per batch
PLA-PCL Copolymer	High demand for resin with relatively high strength and toughness	Compostable in homegrown facilities	Block polymers and copolymers production at the pilot level. Technology ready for pilot-scale production
New Lactone based Bioplastic	Initial stage	No study available	Technology ready for commercialization (TRL 5)
Starch-based packaging	Great possibility with limited applications with short term usability	Compostable	Technology is ready for scale-up for various food packaging applications

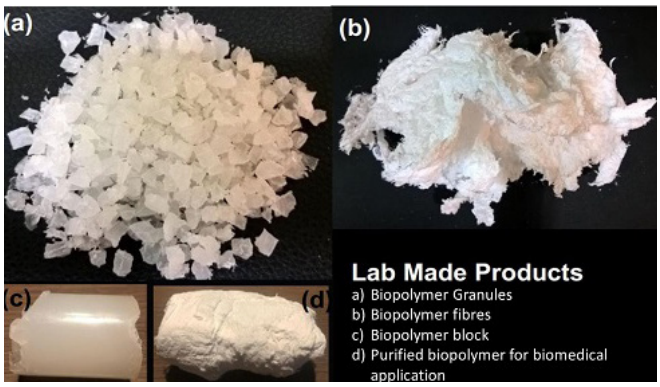


Figure 25: *Lab synthesized biopolymer and biodegradable products*

iv. Technology Status – Indian Industry

There is no essential polymer manufacturer and no company engaged in converting flexible packaging solutions to brand owners in India. However, there are a few companies who are involved in compounding the same based on the import of bioplastics and bio-based polymers to cater to the domestic market for grocery packaging. The material so far is positioned for the grocery and vegetable market. Many technical breakthroughs have bolstered the Indian bioplastics market, which has seen tremendous expansion.

The objective of increasing the shelf life of food ingredients is yet to be achieved by polymers like PLA, PBS, and Poly 3 hydroxybutyrate-co-3-hydroxyvalerate (PHBV) etc.

a. Praj Industries Ltd., Pune, and Lygos Inc., California, have reportedly signed a memorandum of understanding (MoU) under which Lygos' proprietary yeast will be used to facilitate the manufacture of lactic acid.

b. Total Corbion PLA, a 50:50 joint venture between Total and Corbion is planning to enter the Indian bioplastics market (September 2019) in technical partnership with Konkan Specialty Poly Products Pvt Ltd, a polymers and chemicals operator situated in Mangalore, India.

c. Total Corbion PLA may launch a 100% biodegradable and compostable plastic solution as part of the agreement, which will be managed by Konkan Specialty Poly Products Pvt Ltd. The latter will use PLA to make compounds for a variety of purposes.

Many market participants are investing in the R&D of new technologies to bring bioplastics to market in a manner that enables the reduction of end-use costs and ensures faster adoption of bioplastics. Below is the list of Indian companies (Table 10) operating in the bioplastics area.

Table 10: Indian companies operating in the area of bioplastics

Sl. No.	Company Name	Product/ Technology	Capacity (Tons/year)	Biodegradability or Compostability conditions	Applications
1	Envigreen, Bengaluru TRL–9	Starch and Vegetable oil-based	1000	——	Carry bags, Garbage & laundry bags, and other packaging films
2	BioGreen packaging PVt.Ltd., Pune TRL–8	Biodegrada-ble/composta-ble pla.stic		Industrial	Biodegradable food grade bags
3	Ecolife, Chennai TRL–8	PLA based	4000	Industrial	For apparel packaging, carry bags, garbage bags, Industrial packaging and cutleries.
4	SkYI, Pune	PLA blends (BioFlex®) with PBS	10000	Industrial, Home depending on grades	1. Flexible film applications such as agricultural, household and hygiene films 2. Food approved to EC directives and FDA
5	Earth Soul, Mumbai	Licensed manufacturer of Novamont		Industrial & Home	Suitable for garden needs, food packaging and waste disposal purposes.
6	Plastobags, Bengaluru			Industrial	Carry bags, Garbage & Apparel bags
7	Greendiamz, Ahemdabad (Truegreen)		5000	Industrial	Garbage bags, food gloves, shrink films, Cutleries, and laminating materials

6.5 DEVELOPMENT AND PRODUCTION OF PLASTIC ALTERNATIVES COLLABORATIVELY

Various companies are engaged in the research and development of aerobic or anaerobic biodegradable products in collaboration with Indian/International institutions.

Various products like coir mulch mats are at different stages of development which can be seen in the picures as shown in Figure 26.

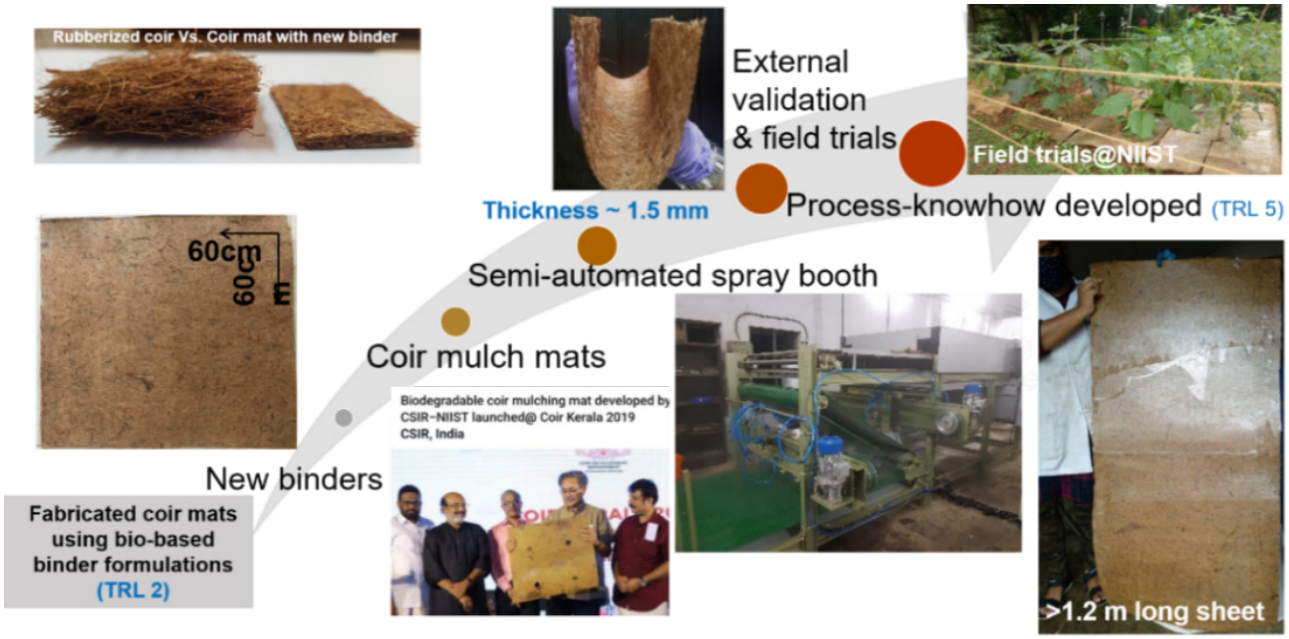


Figure 26: *Technology transfer, scale-up and commercialization by CSIR-NIIST Indian Standards*

Chapter
7

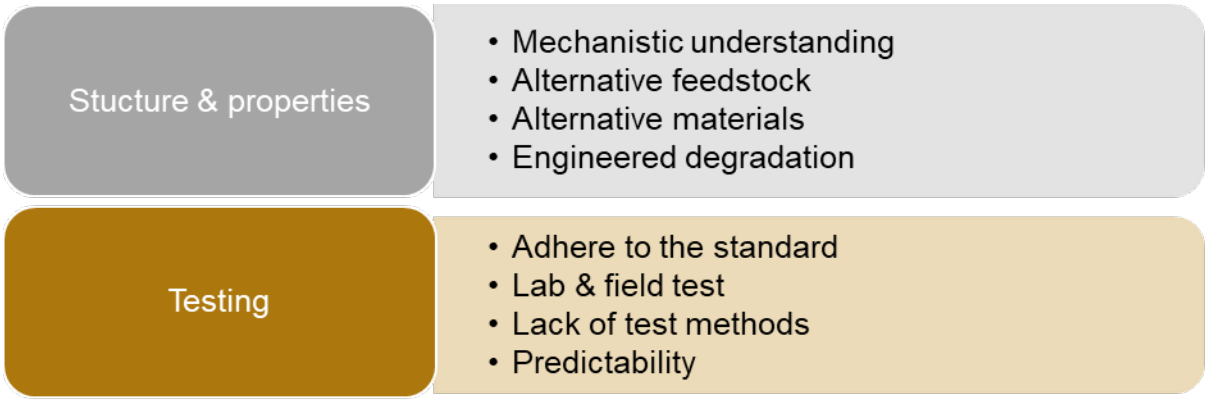
Roadmap for development of plastic alternatives in India

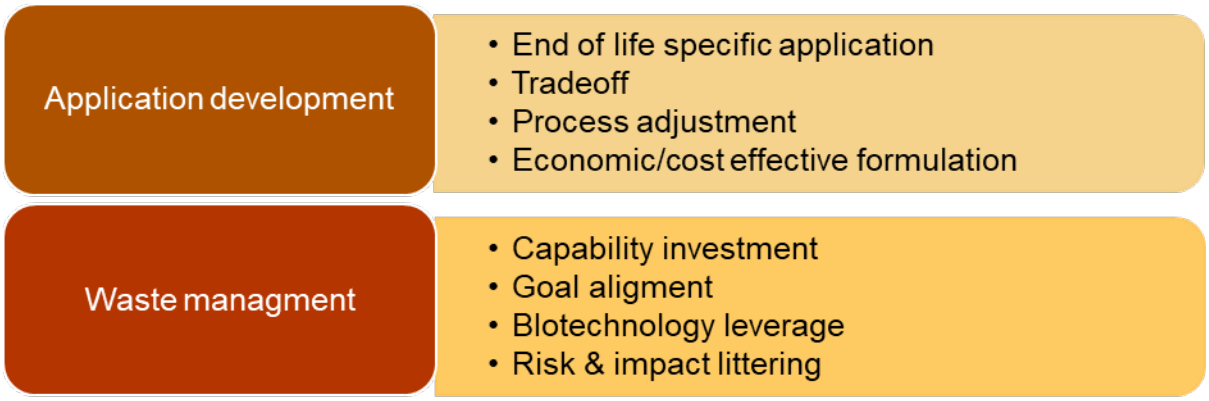
7.1 INVESTMENT AREAS AND POLICY GAPS FOR DEVELOPMENT OF ALTERNATIVES

Investment Areas	Gaps
Stability & Biodegradability	Material/product must be stable & durable during use
Flexibility in a cold environment	Performance at low temperature without deterioration
Food safety & non-toxicity	Safe for food & drug application with other properties
Synergistic additives	Materials which enhance process-ability & properties
Total biodegradation	Stable throughout its useful life & its end of life is complete compostable
Application development	How to develop biodegradable product/material
Testing & analysis	How to test a biodegradable product/material
Waste management	Where to dispose of a biodegradable product

7.2 R&D AND IMPLEMENTATION STRATEGY

R&D needs to focus on the following to overcome existing constraints





The primary directions of R&D on biodegradable plastics to be in the areas of:

1. **Packaging carrier, compost bags and catering products**
   - To improve the sustainability and environmental impact of the product
   - Oxygen-scavenging bioplastic packaging
   - To improve high-barrier packaging technologies (modified polymer, coating & lamination)
   - Application areas–cutlery, plates, cups, straws, food containers etc.
2. **Agriculture and horticulture sector**
   - To develop and enforce production standards for biodegradable films: Since different types of degradable materials can be made into biodegradable films, there are noticeable differences among products. We need to develop universal standards that are more conducive to applying and promoting biodegradable membranes.
   - To improve crop adaptability and regional suitability of biodegradable mulch films: The main effects of plastic film mulching are soil warming, moisture conservation and weed prevention. Biodegradable mulch films should contain suitable degradation characteristics, a reasonable startup period and a degradation rate for crop growth.
   - Develop new testing and evaluation systems for the biodegradation of plastic film mulch
   - Application areas include mulch films, plant pots, nursery films etc.
3. **Health care and hygiene products (medical & dental implants, sutures etc.)**
   - To make them biocompatible with the human body, devices would depend on several factors like implantation site, material-tissue interactions, temperature, and humidity.
   - Applications include surgical sutures, wound dressings, tissue regeneration, enzyme immobilization, controlled drug and gene delivery, tissue engineering, etc.
4. **Automotive**
   - Bio-based plastics and polymers have low carbon footprint.
   - Help reduce the dependency on limited fossil resources, which are expected to increase in price significantly over the coming decades.
   - Bio-based plastics are not as affected by oil price volatility as petroleum-based materials
   - Application areas include connectors, brake noses, fuel lines, flexible tubing, spoilers, dashboards, mats, carpeting, upholstery etc.

5. **Electronics industry**
    - To offer light, flexible, and more cost-effective alternatives to conventional materials of solar cells, light-emitting diodes, and transistors.
    - To identify the weaknesses in currently available biopolymers in order to improve future biopolymers
    - Application areas–printed flexible conductors, novel semiconductor components, intelligent labels, large-area displays, solar panels etc.)
    - 3D printing (additive manufacturing)

7.3 COST-BENEFIT ANALYSIS

While environmentally friendly biodegradable plastics are a desirable solution, it is critical to fulfilling required functional performance parameters (i.e., moisture barrier, heat sealability, etc.) to maintain product integrity. Many biodegradable plastics often fail to meet these desired functional parameters resulting in significant end-product wastages. Therefore, developing biodegradable plastics with the required functional properties to protect product integrity though challenging is critical.

Way forward

1. **Significant financial outlays to be reserved to promote alternate plastics**
    - Alternative plastics such as PLA, PHAs, poly(caprolactone) etc., have to be promoted with industry interventions.
    - Development of an exhaustive framework and budget distribution for research and development of alternative plastics
    - Monitoring of the outcomes and deliverables of the research and its technology readiness
    - Budget allocation from the Department of Chemicals and fertilizers, Food processing industries, environment, forest, and climate change.
2. **Available R&D centers on alternatives of plastics to be identified**
    - Identification of the state and central R&D facilities
    - Identification and promotion the non-government organizations
    - Identification of non-profit organizations
    - Identification of rural development organizations and CSRs for the development of alternative plastics
    - Promotion of IITs, NITs, CSIR, IISER, CIPET and other premier institutes to collaborate on technology development and commercialization
    - Identification of contract research organizations for fast-paced commercialization and financial contribution
3. **A national level centre on bioplastic translational research will be established on a priority basis with researchers & industries**
    - The translation of any technology to widespread industrial adoption level is an essential step toward cost reduction and commercialization of bio-degradable plastics

- The technology developed through R&D efforts will be adopted within industries through collaborations focused on end-user needs
- The development of the national level bioplastic translational research centre through which the state centres are aligned and monitored
- Development of the national level translational centres in each state of the country under the governance of the national level central office

4. **Strategies have to be adopted for creating relevant skills and technical workforce through a network of Master's, PhD, and certificate programs aligned to the needs of industry & research**
   - Introduction of courses in academic institutions to train people on topics of sustainability in plastics
   - Introduction of certificate programs and diploma programs in the field of polymer processing and development
   - Introduction of management courses such as MBA for marketing and post-market analysis of the biodegradable plastics
5. **Consortium based activities to drive holistic development of the alternate plastic ecosystem**
   - Association of government agencies and industry players to enable effective knowledge exchange
   - Organization of annual meetings and lectures to gain knowledge on technology development
   - Annual evaluation of emerging technology innovations and recognizing appropriate innovators and entrepreneurs

a. Framework for incentivizing industries

Encouragement for further R&D focused on more eco-friendly materials with required functional properties is essential for India to remain competitive in the international market. There is significant potential to leverage private sector investment in research for more eco-friendly plastics through public-private partnerships. Therefore, Indian plastic manufacturers and brand owners should be encouraged to collaborate for R&D with leading research institutions (CSIR, CIPET, DRDO, IITs) to develop and further improve indigenous technologies for bio-degradable materials for a wide range of applications, including those with relevant functional properties to facilitate the mission of "Atmanirbhar Bharat".

There is a need to take direct financial (through grants, loans, tax relaxation etc.) and indirect financial (through R&D tax incentives) efforts to promote biodegradable plastics for large scale adoption of such innovation. Consumer awareness drives should simultaneously be undertaken to sensitize the public about biodegradable plastics related environmental benefits, which will help in replacing conventional plastics with ecofriendly biodegradable solutions.

b. R&D pathways and investment areas for development of bio-degradable plastics

Breakthrough innovations globally have made it possible to convert polyolefin-based plastics to completely bio-degradable plastics. Given the immense scope, improving the sustainability and environmental impact of the product, and no additional requirements of plant and machineries for manufacturing bio-degradable plastics, research is to focus on the development and application of other chemicals, additives, or feasibility makes even resins biodegradable.

Further, there would be an urgent need to upgrade the infrastructure of Government and commercial testing laboratories. They are well equipped to test plastics according to IS mentioned in Schedule I of PWM Rules. Manufacturers should also be encouraged through appropriate measures to shift from conventional plastics to biodegradable plastics across categories.

An approach of masterbatch regulatory clearance for biodegradable plastics instead of product-wise regulatory approval should be accepted. This would be cost-effective and time-efficient. Technical know-how for manufacturing biodegradable plastics should be transferred to concerned industries for large scale production.

c. Implementation strategy for the development of bio-degradable plastics

DST's Science & Engineering Research Board (SERB) may give a special call on alternative products to generate know-how and establish proof of concepts in this area (time frame 1-3 years). Technology development (scale-up and validation)–a top-down approach to deliver the technologies up to TRL 7 through technology development programs with mandatory Industry participation (time frame 2 – 3 years). Existing schemes of DST and DBT may be leveraged to promote industries engaged in the upscaling and commercialization of related technologies (6months – 2 years).

Furthermore, focused areas on lines similar to EU research and innovation programme as listed below may be followed:

1. **EFFECTIVE**: advanced eco-designed fibres and films for large consumer products from bio-based polyamides and polyesters in a circular economy perspective
2. **ECOFUNCO**: eco-sustainable multifunctional bio-based coatings with enhanced performance and end of life options.
3. **Usable Packaging**: unlocking the potential of sustainable, biodegradable packaging
4. **BIONTOP**: novel packaging films and textiles with tailored end of life and performance based on bio-based copolymers and coatings.
5. **MANDALAB**: the transition of multilayer/multipolymer packaging into more sustainable multilayer/single polymer products for the food and pharma sectors through the development of innovative functional adhesives.
6. **NENU2PHAR**: for a sustainable European value chain of PHA-based materials for high-volume consumer products.

Chapter
8

Recommendations

1. **Strengthening waste minimization through extended producer responsibility:**

   The most preferred option for the management of waste is waste minimization. The new EPR guidelines say that the generators of plastic waste need to take steps to minimize the generation of plastic waste they introduce into the market. This is, however, not applicable to PIBOs. Offering a diverse range of packaging materials, apart from plastics, to consumers should be scaled up through incentives in the form of EPR certificates to the PIBOs. This would encourage them to diversify their packaging and reduce the number of plastics they put out in the market and would also help brands develop a green image, especially among conscious consumers.

2. **Proper labelling and collection of compostable and biodegradable plastics:**

   European standards for assessing the compostability of plastics have clear labelling for industrial composting and home composting. Plastic materials or products fulfilling these standards are certified and labelled accordingly. As per the SOP by CPCB, issuing a certificate for compostable plastic manufacturers/sellers, marked as "compostable" or "compostable in municipal and industrial composting facilities" or "biodegradable during composting" is considered equivalent. The most recent International Organization for Standardization (ISO) 17088:2021 (plastics-organic recycling-specifications for compostable plastics) explicitly mentions that the "aspects are suitable to assess the effects on the industrial composting process". It is also mentioned that these standards are "not applicable to the biological treatment undertaken in small installations by householders". Testing, certification, and proper labelling become important aspects when promoting products like biodegradable and compostable plastics.

   Also, industrial composting facilities are very limited in India, and it is challenging to promote widespread adoption of compostable plastic. Also, compostable plastics cannot be recycled; if they make it to a recycling facility, they may end up contaminating the plastic that could have been recycled. Hence, the EPR exemption on compostable plastics should be removed and they should be brought under EPR. Definition of industrial composting should be added to EPR guidelines and PWM rules, and a standard operating procedure (SOP) should be developed accordingly.

3. **Updation of Standards under Schedule – I (PWM Rule)**

   The standards available in the regulatory framework (Schedule – I) should be updated with the latest versions, and Rule 10 should be modified as "protocols for compostable and biodegradable

plastic materials". Determination of degree of degradability and degree of disintegration of plastic materials should be as per the protocols of the IS listed in Schedule – I to these rules, as amended from time to time.

In India, a lot of plastic waste ends up in landfills. Standards applicable to anaerobically biodegradable materials are not covered in IS/ISO 17088 and should be included along with the latest version of IS/ISO 15985:2014 – anaerobic degradation of plastics. Adoption of this standard would be significant for ensuring that plastics that reach landfills, biodegrade. Disintegration does not feature in the standards for aerobic biodegradation, IS/ISO 17556:2012 and IS/ISO 17556:2019; hence the disintegration step requirement for compostable plastics should not be included in PWM rules. The biodegradable plastics complying with IS as mentioned in Schedule I, PWM Rule should be accepted and the exemption as given to compostable plastics should be extended to completely biodegradable plastics in Rule 4(3) and Rule 4(1)(h).

Rule 7.8 of the EPR regulations, notified on the 16th February 2022, also factors in the encouragement of the usage of biodegradable plastics through the exemption from EPR targets for the same. However, this rule needs to be made consistent with PWM rules and should be amended to read as "In case the obligated entity utilizes plastic packaging which is biodegradable as per the standards defined in the PWM Rules, the EPR target will not be applicable for such material."

4. **Relaxation period for adoption of biodegradable plastics:**

The timeframe for analysis according to the latest standards for biodegradable plastics is two and a half years. There is a waiting period for potential eco-friendly plastic samples for testing due to the limited capacity of laboratories equipped with testing infrastructure for compostability and biodegradability analysis and the long testing time according to Indian Standards. Also, equipment failures sometimes cause delays in carrying out tests or limit the testing capacity in these laboratories.

Considering the testing period requirements and the limited number of testing accredited laboratories in our country, the industry may be given adequate time of at least three years before the implementation of the provision of PWM (amendment) Rules 2021. However, an alternate methodology may be worked out to expedite and simplify the regulatory approvals process to reduce the waiting period for the industry to bring appropriate products into the market. CPCB should recognize all ISO 17025 Indian laboratories in addition to the CIPET laboratory and authorize testing of all parameters required by plastic manufacturers according to IS as listed under the PWM rule.

Additionally, biodegradable plastic that has been tested to meet International Standards such as ASTM D5511 or BSI PAS 9017 and shows promising results in the initial test against Indian Standards in laboratories could be given provisional approval to be used in the country for a period till the test results in India are completed.

5. **Increasing transparency in the process:**

The centralized portal being developed by CPCB to disclose the amount of plastic handled can only be accessed by PIBOs, PWPs/recyclers, SPCBs / PCCs, and CPCB. PWPs are supposed to reveal the total amount of plastic waste handled on their websites. This will also be available on the centralized CPCB portal. The PIBOs, however, have not been directed to disclose the amount of plastic they place in the market. Inclusion of PIBOs in this disclosure process and making the portal available in the public domain would help in greater accountability, eliminate

greenwashing, and help brands position themselves as a low carbon-footprint organization.

6. **Inclusion of the informal sector in EPR:**

According to the Federation of Indian Chamber of Commerce and Industry (FICCI), the plastics recycling industry in India employs over 1.6 million people and has more than 7,500 recycling units. In India, recycling has been managed by very small size players, who use elementary waste segregation processes and lack scientific know-how on waste collection, segregation, and disposal. While the informal sector's waste recycling operations are unlicensed and unregulated, they can potentially contribute to the national economy. A model for integration of the informal sector under EPR guidelines should be framed to achieve these fundamental objectives.

7. **Encouraging R&D and incentivizing the manufacturing sector:**

Given the significant potential overall and the promise of recent innovations, increased investment in the development and application of biodegradable plastic is required to move towards a sustainable plastics economy. Based on the functionality and deliverables, R&D can be focused on the following domains:

- **Packaging**: food, bottles, containers, sheets, films, laminates, fibres, and coatings
- **Agriculture**: mulch, water absorbents
- **Healthcare**: artificial implant materials, surgical sutures, wound dressings, tissue regeneration, enzyme immobilization, controlled drug delivery and gene delivery, tissue engineering, and medical devices.
- **Electronics**: wearable electronic and therapeutic devices.
- **Development of biodegradable products** via additive manufacturing for automobile applications.

This R&D development can be supported through programs such as the EU Research and Innovation Programme. The Indian plastic manufacturers should be encouraged to collaborate with leading research institutions (CSIR, CIPET, DRDO, IITs) to develop indigenous technology for biodegradable materials for a wide range of applications, including those with functional properties for a level playing field and to actualize the Make in India vision. Research laboratories are to be given opportunities to conduct research on various test protocols available internationally (ISO/TR 21960:2020 Plastics – Environmental aspects – State of knowledge and methodologies).

8. **Others**

In addition to intensifying research activities in bio-derived polymers or biodegradable polymers in academic institutions and industries, there has to be a collective nationwide and societal approach towards the reuse and recycling of plastics to address the widespread problem of plastic pollution.

The specific plans could include the following:

d. Lowering taxes including GST on plastic scrap

e. Organizing awareness programs and seminars at regular intervals

Annexures

ANNEXURE I: COMPOSITION AND TERMS OF REFERENCE FOR THE COMMITTEE

F. No. 12074/1(12)/2021-E&F
Government of India
NITI Aayog
(NRE Vertical- E&F)

Sansad Marg, New Delhi
Dated June 07th, 2021

ORDER

Subject: Constitution of a Committee to find out/develop an alternative product to plastic

A Committee has been constituted to find out/develop an alternative product to plastic. The Committee will be chaired by Member (S&T), NITI Aayog. The composition of the committee shall be as follows:

S. No.	Composition	Designation in Committee
1	Shri V.K. Saraswat, Member (S&T), NITI Aayog	Chairperson
2	Prof. Ashutosh Sharma, Secretary(Department of Science and Technology)	Vice Chairperson
2	Shri Samir Kumar Biswas, Director General, CIPET	Member
3	Dr. Ashish Lele, Director, CSIR-National Chemical Laboratory (NCL)	Member
4	Dr. Mayank Dwivedi, Director, DRDO (HQ)	Member
5	Joint Secretary Level Officer from MoEF&CC	Member
6	Dr. Virendra Gupta, Senior Vice President and Head R&D Polymer, Reliance Industries Limited	Member
7	Prof. Vimal Katiyar, IIT (Guwahati)	Member
8	Prof. A. K. Ghosh, IIT(Delhi)	Member
9	Representative of TIFAC	Member
10	Representative of Central pollution Control Board (CPCB)	Member
11	Shri Avinash Mishra, Adviser (NRE)	Member-Secretary

The Terms of reference of the committee will be as follows:

1. To assess the Status of Development of Bio-degradable Plastics and material globally.
2. The Directions of Research and Development being taken by Global Majors.
3. Status of Domestic R&D by Public and Private Polymer manufacturers, R&D Institutions / Strategies to catalyze the Research and Development of Bio-degradable Plastics and the role of Public funded R&D projects in this domain.
4. Research in Bio-degradable polymers has to be done to meet the requirements of Automobiles, Agriculture Sector and other Industrial applications.

5. Scale up, translation and production shall be funded by Industry who will also be responsible for large scale commercialization .
6. Industry Partners will facilitate and will be responsible for identification of different products and the application thereof for R&D teams to conduct research accordingly.
7. Committee will approve the project proposals, monitor the progress and coordinate commercialization with Industry
8. The Finances for the research programme will be borne by Department of Science and Technology.
9. Major R&D projects can be supported by Government of India or jointly by Government of India and Industry.

(L Gopinath)
Sr. Research Officer
E-mail:gopinath.lagudu@nic.in

To
Chairperson/Members of the Committee

Copy for information to:

1. PS to Hon'ble Vice-Chairman, NITI Aayog
2. PSO to CEO, NITI Aayog

F. No. 12074/1(12)/2021-E&F
Government of India
NITI Aayog
(NRE Vertical- E&F)

Sansad Marg, New Delhi
Dated June 29th, 2021

ORDER

Subject: Constitution of a Committee to find out/develop an alternative product to plastic

In continuation of the order dated 07.06.2021 (Copy enclosed) on the subject mentioned above. It is to inform that the following members have been added in the Committee to find out/develop an alternative product to plastic:-

S. No.	Composition	Designation in Committee
12	Representative of Department of Bio Technology	Member
13	Representative of Federation of Indian Chambers of Commerce & Industry (FICCI) and three representatives from industries of FICCI	Member
14	Dr. Manatesh D Chakraborty, principal Scientist, ITC Limited	Member

The Terms of reference of the committee will be as follows:

1. To assess the Status of Development of Bio-degradable Plastics and material globally.
2. The Directions of Research and Development being taken by Global Majors.
3. Status of Domestic R&D by Public and Private Polymer manufacturers, R&D Institutions / Strategies to catalyze the Research and Development of Bio-degradable Plastics and the role of Public funded R&D projects in this domain.
4. Research in Bio-degradable polymers has to be done to meet the requirements of Automobiles, Agriculture Sector and other Industrial applications.
5. Scale up, translation and production shall be funded by Industry who will also be responsible for large scale commercialization .
6. Industry Partners will facilitate and will be responsible for identification of different products and the application thereof for R&D teams to conduct research accordingly.
7. Committee will approve the project proposals, monitor the progress and coordinate commercialization with Industry

8. The Finances for the research programme will be borne by Department of Science and Technology.
9. Major R&D projects can be supported by Government of India or jointly by Government of India and Industry.

(L Gopinath)
Sr. Research Officer
E-mail:gopinath.lagudu@nic.in

To
Chairperson/Members of the Committee

Copy for information to:

1. PS to Hon'ble Vice-Chairman, NITI Aayog
2. PSO to CEO, NITI Aayog

ANNEXURE II: PWM RULES (2011, 2016, 2018, 2021, DRAFT-2022)

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 4th February, 2011

S.O. 249(E).— Whereas the draft rules, namely, the Plastics (Manufacture, Usage and Waste Management) Rules, 2009 were published by the Government of India in the Ministry of Environment and Forests vide number S.O. 2400(E), dated the 17th September, 2009 in the Gazette of India, Extraordinary of the same date inviting objections and suggestions from all persons likely to be affected thereby, before the expiry of a period of sixty days from the date on which copies of the Gazette containing the said notification were made available to the public;

AND WHEREAS copies of the said Gazette were made available to the public on the 17th day of September, 2009;

AND WHEREAS the objections and suggestions received within the said period from the public in respect of the said draft rules have been duly considered by the Central Government.

NOW, THEREFORE, in exercise of the powers conferred by sections 3, 6, and 25 of the Environment (Protection) Act, 1986 (29 of 1986), and in supersession of the Recycled Plastics Manufacture and Usage Rules, 1999, except as respects things done or omitted to be done before such supersession, the Central Government hereby makes the following Rules, namely:-

1. Short title and commencement .-

(1) These rules may be called the Plastic Waste (Management and Handling) Rules, 2011.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. Application.-

The provisions of rules 5 and 8 shall not apply to the manufacture of carry bags exclusively for export purposes, by export oriented manufacturing units, against an order for export received by the owner or occupier of the concerned manufacturing unit. This exemption does not apply to any surplus or rejects, left over and the like.

400 GI/2011—3

3. **Definitions.**- In these rules, unless the context otherwise requires .-

(a) **"Act"** means the Environment (Protection) Act, 1986 (29 of 1986);

(b) **"Carry bags"** mean all plastic bags used to carry commodities, including self carrying features;

(c) **"Commodities"** mean articles; including but not limited to vegetables, fruits, pharmaceuticals, food grains and the like;

(d) "**Compostable plastics**" mean plastic that undergoes degradation by biological processes during composting to yield CO_2, water, inorganic compounds and biomass at a rate consistent with other known compostable materials and does not leave visible, distinguishable or toxic residue;

(e) **"Consent"** means the consent to establish and operate from the concerned State Pollution Control Board or Pollution Control Committee granted under the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974), and the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981);

(f) "**Disintegration**" means the physical breakdown of a material into very small fragments;

(g) **"Extended producer's responsibility (EPR)"** means the responsibility of a producer or manufacturer of plastic carry bags and multilayered plastic pouches or packages for the environmentally sound management of the product until the end of its life. This responsibility also applies to all manufactures using such packaging;

(h) **"Food-stuffs"** mean ready to eat food products, fast food, processed or cooked food in liquid, powder, solid or semi-solid form;

(i) **"Manufacturer"** means any producer who manufactures plastic carry bags, multilayered packaging, pouches and the like or uses such materials in packaging of a product;

(j) **"Municipal authority"** means Municipal Corporation, Municipality, Nagar Palika, Nagar Nigam, Nagar Panchayat, Municipal Council including notified area committee (NAC) or any other local body constituted under the relevant statutes and, where the management and handling of municipal solid waste is entrusted to such agency;

(k) **"Multilayered plastics"** mean any material having a combination of more than one layer of packaging material such as paper, paper board, polymeric materials, metalised layers or aluminium foil, either in the form of a laminate or co-extruded structure;

(l) **"Plastic"** means material which contains as an essential ingredient a high polymer and which at some stage in its processing into finished products can be shaped by flow;

(m) **"Plastic waste"** means any plastic product such as carry bags, pouches or multilayered packaging, which have been discarded after use or after their intended life is over;

(n) **"Registration"** means registration of units manufacturing or recycling carry bags made of virgin or recycled plastics with the concerned State Pollution Control Board or Pollution Control Committee, as the case may be;

(o) **"Virgin plastic"** means plastic material which has not been subjected to use earlier and has also not been blended with scrap or waste;

(p) **"Waste management"** means the scientific reduction, re-use, recovery, recycling, composting or disposal of plastic waste;

(q) **"Waste pickers"** mean individuals or groups of individuals engaged in the collection of plastic waste.

4. Prescribed Authority.-

The prescribed Authority means the Authority-

(a) for enforcement of the provisions of these rules related to authorization, manufacture, recycling and disposal shall be State Pollution Control Board and Pollution Control Committee in respect of Union territory;

(b) for enforcement of the provisions of these rules relating to the use, collection, segregation, transportation and disposal of post consumer plastic waste shall be the concerned municipal authority.

5. **Conditions.**- During the course of manufacture, stocking, distribution, sale and use of carry bags and sachets, the following conditions shall be fulfilled, namely:-

(a) carry bags shall either be white or made using only those pigments and colourants which are in conformity with Indian Standard : IS 9833:1981 titled as List of pigments and colourants for use in plastics in contact with foodstuffs, pharmaceuticals and drinking water, as amended from time to time;

(b) no person shall use carry bags made of recycled plastics or compostable plastics for storing, carrying, dispensing or packaging food stuffs;

(c) no person shall manufacture, stock, distribute or sell any carry bag made of virgin or recycled or compostable plastic, which is less than 40 microns in thickness;

(d) sachets using plastic material shall not be used for storing, packing or selling gutkha, tobacco and pan masala;

(e) recycled carry bags shall conform to the Indian Standard: IS 14534:1998 titled as Guidelines for Recycling of Plastics, as amended from time to time;

(f) carry bags made from compostable plastics shall conform to the Indian Standard: IS/ISO 17088:2008 titled as Specifications for Compostable Plastics, as amended from time to time.

6. **Plastic Waste Management.-**

The plastic waste management shall be as under:-

(a) recycling, recovery or disposal of plastic waste shall be carried out as per the rules, regulations and standards stipulated by the Central Government from time to time;

(b) recycling of plastics shall be carried out in accordance with the Indian Standard : IS 14534:1998 titled as Guidelines for Recycling of Plastics, as amended from time to time;

(c) the municipal authority shall be responsible for setting up, operationalisation and co-ordination of the waste management system and for performing the associated functions, namely:- (i) to ensure safe collection, storage, segregation, transportation, processing and disposal of plastic waste; (ii) to ensure that no damage is caused to

the environment during this process; (iii) to ensure setting up of collection centres for plastic waste involving manufacturers; (iv) to ensure its channelisation to recyclers; (v) to create awareness among all stakeholders about their responsibilities; (vi) to engage agencies or groups working in waste management including waste pickers, and (vii) to ensure that open burning of plastic waste is not permitted;

(d) for setting up plastic waste collection centres, the municipal authority may ask the manufacturers, either collectively or individually in line with the principle of Extended Producer's Responsibility (EPR) to provide the required finance to establish such collection centre;

(e) recyclers shall ensure that recycling facilities are in accordance with the Indian Standard: IS 14534:1998 titled as Guidelines for Recycling of Plastics and in compliance with the rules under the Environment (Protection) Act, 1986, as amended from time to time;

(f) the concerned municipal authority shall ensure that the residues generated from recycling processes are disposed of in compliance with Schedule II (Management of Municipal Solid Wastes) and Schedule III (Specifications for Landfill Sites) of the Municipal Solid Wastes (Management and Handling) Rules, 2000 made under the Environment (Protection) Act, 1986, as amended from time to time;

(g) the municipal authority shall incorporate the said rules in the Municipal bye laws of all the Urban Local Bodies;

(h) the municipal authority shall encourage the use of plastic waste by adopting suitable technology such as in road construction, co-incineration etc. The municipal authority or the operator intending to use such technology shall ensure the compliance with the prescribed standards including pollution norms prescribed by the competent authority in this regard.

7. **Protocols for Compostable Plastic Materials.** - Determination of the degree of degradability and degree of disintegration of plastic material shall be as per the protocols of the Indian Standards listed in the Annexure to these rules.

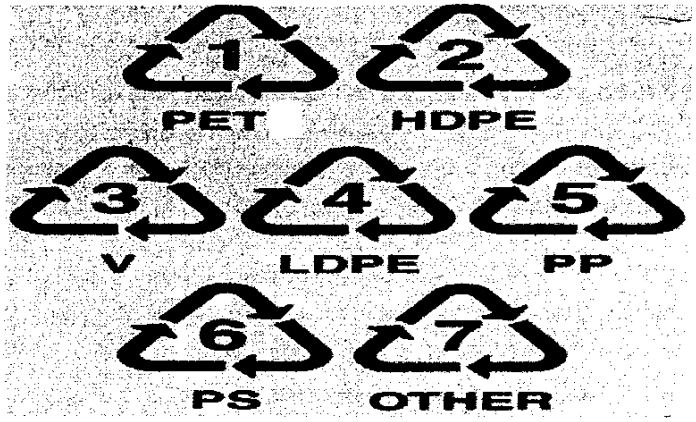
8. Marking or Labelling.-

(a) each plastic carry bag and multilayered packaging shall have the following information printed in English or in local language, namely:-

(i) name, registration number of the manufacturer and thickness in case of carry bag;

(ii) name and registration number of the manufacturer in case of multilayered packaging.

(b) each recycled carry bag shall bear a label or a mark "recycled" as shown below and shall conform to the Indian Standard: IS 14534: 1998 titled as Guidelines for Recycling of Plastics, as amended from time to time;



NOTE: PET-Polyethylene terephthalate, HDPE-High density polyethylene, V-Vinyl (PVC), LDPE- Low density polyethylene, PP-Polypropylene, PS-Polystyrene and Other means all other resins and multi-materials like ABS (Acrylonitrile butadiene styrene), PPO (Polyphenylene oxide), PC (Polycarbonate), PBT (Polybutylene terephalate) etc.

(c) each carry bag made from compostable plastics shall bear a label "compostable" and shall conform to the Indian Standard : IS/ISO 17088:2008 titled as Specifications for Compostable Plastics;

(d) retailers shall ensure that plastic carry bags and multilayered packaging sold by them are properly labelled, as per stipulations under these rules.

9. Registration of Manufacturers and Recyclers.-

(a) any person manufacturing or proposing to manufacture carry bags and multilayered plastics shall apply to the State Pollution Control Board (SPCB) or Pollution Control Committee (PCC) of the Union territory concerned for the grant of registration or for the renewal of registration for the manufacturing unit using Form 1 appended to these rules;

(b) any person recycling or proposing to recycle carry bags or multilayered plastics or any plastic waste shall apply to the SPCB or PCC for grant of registration or renewal of registration for the recycling unit using Form 2 appended to these rules;

(c) no person shall manufacture carry bags or recycle plastic bags or multilayered plastics unless without obtaining the registration certificate from the SPCB or PCC, as the case may be, prior to the commencement of production;

(d) the SPCB and PCC shall not issue or renew a registration for manufacturing or recycling units unless the unit possesses a valid consent under the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974) and the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981) and certificate of registration issued by the District Industries Centre or any other government agency authorised in this regard;

(e) every State Pollution Control Board or Pollution Control Committee shall take a decision on the grant of registration within ninety days of receipt of an application that is complete in all respects;

(f) the registration granted under this rule shall be valid for a period of three years, unless revoked, suspended or cancelled; and registration shall not be revoked, suspended or cancelled without providing the manufacturer an opportunity for a hearing;

(g) every application for renewal of registration shall be made at least ninety days before the expiry of the validity of the registration certificate.

10. Explicit pricing of carry bags.-

No carry bags shall be made available free of cost by retailers to consumers. The concerned municipal authority may by notification determine the minimum price for carry bags depending upon their quality and size which covers their material and waste management costs in order to encourage their re-use so as to minimize plastic waste generation.

11. State Level Advisory Body.-

(1) There shall be a State Level Advisory Body to monitor the implementation of these Rules.

(2) The State Level Advisory Body shall consist of the following persons, namely:-

(a) the Secretary, Department of Urban Development	- Chairman
(b) one expert from State Department of Environment	- Member
(c) one expert from State Pollution Control Board or Pollution Control Committee	- Member
(d) one expert from Urban Local Body	- Member
(e) one expert from Non-Governmental Organisation	- Member
(f) one expert from the field of Industry	- Member and
(g) one expert from the field of academic institution	- Member

(3) The State Level Advisory Body shall meet at least once in a year and may invite experts, if it considers necessary.

12. Annual Reports.-

(1) each State Pollution Control Board or Pollution Control Committee shall prepare and submit the annual report to the Central Pollution Control Board on the implementation of these rules by the 30th day of September of each year;

(2) the Central Pollution Control Board shall prepare a consolidated annual report on the use and management of plastic waste and forward it to the central government along with its recommendations before the 30th day of December each year.

[F. No. 17-2/2001-HSMD]

RAJIV GAUBA, Jt. Secy.

ANNEXURE

[See rule 7]

1.	IS/ISO 14851: 1999 Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium-Method by measuring the oxygen demand in a closed Respirometer
2.	IS/ISO 14852: 1999 Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium-Method by analysis of evolved carbon dioxide
3.	IS/ISO 14853: 2005 Plastics- Determination of the ultimate anaerobic biodegradation of plastic materials in an aqueous system-Method by measurement of biogas production
4.	IS/ISO 14855-1: 2005 Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions-Method by analysis of evolved carbon dioxide (Part-1 General method)
5.	IS/ISO 14855-2: 2007 Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions-Method by analysis of evolved carbon dioxide (Part-2: Gravimetric measurement of carbon dioxide evolved in a laboratory- scale test)
6.	IS/ISO 15985: 2004 Plastics- Determination of the ultimate anaerobic biodegradation and disintegration under high-solids anaerobic digestion conditions- Methods by analysis of released biogas
7.	IS/ISO 16929: 2002 Plastics- Determination of degree of disintegration of plastic materials under defined composting conditions in a pilot - scale test
8.	IS/ISO 17556: 2003 Plastics- Determination of ultimate aerobic biodegradability in soil by measuring the oxygen demand in a Respirometer or the amount of carbon dioxide evolved
9.	IS/ISO 20200:2004 Plastics- Determination of degree of disintegration of plastic materials under simulated composting conditions in a laboratory - scale test

FORM - I

[See rules 9]

APPLICATION FOR REGISTRATION OF A UNIT FOR THE MANUFACTURE OF PLASTIC CARRY BAGS AND MULTILAYERED PLASTICS

From: .....

.....

.....(Name and full address of the occupier)

To

The Member Secretary,

..... Pollution Control Board/Pollution Control Committee

.....

.....

Sir,

I/We hereby apply for registration under rule 9 of the Plastic Waste (Management and Handling) Rules, 2011

PART – A GENERAL		
1.(a)	Name and location of the unit	
(b)	Address of the unit	
(c)	Registration required for manufacturing of: (i) Carry bags: (ii) Multilayered plastics	
(d)	Manufacturing capacity	
(e)	In case of renewal, previous registration number and date of registration	
2.	Is the unit registered with the DIC/DCSSI of the State Government/Union territory? If yes, attach a copy.	
3.(a)	Total capital invested on the project	
(b)	Year of commencement of production	
4. (a)	List and quantum of products and by-products	
(b)	List and quantum of raw materials used	
5.	Furnish a flow diagram of manufacturing process showing input and output in terms of products and waste generated including for captive power generation and water.	

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6.	Minimum sizes and thickness of carry bags to be manufactured	
7.	Status of compliance with these rules	
	PART – B PERTAINING TO LIQUID EFFLUENT AND GASEOUS EMISSIONS	
8.	(a) Does the unit have a valid consent under the Water (Prevention and control of Pollution) Act, 1974 (6 of 1974)? If yes, attach a copy	
	(b) Does the unit have a valid consent under the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981)? If yes, attach a copy	
	PART – C PERTAINING TO WASTE	
9.	Solid Wastes: (a) Total quantum of waste generated (b) Mode of storage within the plant (c) Provision made for disposal of wastes	
	Name and Signature Designation Date : Place :	

FORM - 2

[see rule 9]

APPLICATION FORM FOR REGISTRATION OF FACILITIES POSSESSING ENVIRONMENTALLY SOUND MANAGEMENT PRACTICES FOR RECYCLING PLASTIC WASTE

1.	Name and Address of the unit	
2.	Contact person with designation, Tel./Fax /email	
3.	Date Commissioned	

4.	No. of workers (including contract labour)			
5.	Consents Validity	a. Water (Prevention & Control of Pollution) Act, 1974; Valid up to _____ b. Air (Prevention & Control of Pollution) Act, 1981; Valid up to_____		
6.	Authorization validity			
7.	Manufacturing Process	Please attach a flow diagram of the manufacturing process flow diagram for each product.		
8.	Products and installed capacity of production (MTA)	Products		Installed capacity
9.	Products manufactured during the last three years (as applicable)	Year	Product	Quantity
10.	Raw material consumed during the last three years (as applicable)	Year	Product	Quantity
11.	Water consumption	Industrial _____m^3/day Domestic_____m^3 / day		
	Date until which water cess has been paid (if applicable)			
	Waste water generation as per consent _____m^3/day	Actual waste water generated (average of last 3 months) Industrial _____m^3 /day Domestic _____m^3 /day		
	Waste water treatment (provide flow diagram of the treatment scheme)	Industrial Domestic		
	Waste water discharge	Quantity _____m^3/day Location _____ Analysis of treated waste water for pH, BOD, COD, SS, O&G, any other parameter stipulated by SPCB/PCC (attach details)		
12.	Air Pollution Control			
	a. Provide a flow diagram for emission control system(s) installed for each processing unit, utilities etc.			

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	b. Details for facilities provided for control of fugitive emissions due to material handling, process, utilities etc.				
	c. Fuel consumption	Fuel		Qty per day/month	
		(i)			
		(ii)			
	d. Stack emission monitoring	Stack attached to		Emission (SPM, SO_2, NOx , etc.) mg/Nm3	
		(i)			
		(ii)			
	e. Ambient air quality	Location Results $\mu g/m^3$		Parameters SPM, SO_2, NOx, etc.) $\mu g/m^3$	
		(i)			
		(ii)			
13.	Waste Management:	S No	Type	Category	Qty.
	a. Waste generation in processing plastic-waste	(i)			
		(ii)			
		(iii)			
	b. Waste Collection and transportation (attach details)				
	c. Waste Disposal details	S No	Type	Category	Qty
		(i)			
		(ii)			
	d. Provide details of the disposal facility, whether the facility is authorized by SPCB/SPCC				
	e. Please attach analysis report of characterization of waste generated (including leachate test if applicable)				
14.	Details of plastic waste proposed to be acquired through sale, auction, contract or import, as the case may be, for use as raw material	(i) Name (ii) Quantity required /year			
15.	Occupational safety and health aspects	Please provide details of facilities			
16.	Remarks:				
	Whether the unit has adequate pollution control systems / equipment to meet the standards of emission / effluent.	If Yes, please furnish details			

	Whether unit is in compliance with conditions laid down in the said rules.	Yes/No
	Whether conditions exist or are likely to exist of the material being handled / processed posing adverse immediate or delayed impacts on the environment.	Yes/No
	Whether conditions exist (or are likely to exist) of the material being handled / processed by any means capable of yielding another material (e.g. leachate) which may possess eco-toxicity.	Yes/No
17.	Any other relevant information	
18.	List of enclosures as per rule	

Name and Signature

Designation

Date :

Place :

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अधिसूचना

नई दिल्ली, 18 मार्च, 2016

सा.का.नि. 320(अ).—भारत सरकार, तत्कालीन पर्यावरण और वन मंत्रालय द्वारा अधिसूचना संख्या का.आ. 249(अ), तारीख 4 फरवरी, 2011 के *तहत* प्लास्टिक अपशिष्ट (प्रबंध और प्रहस्तन) नियम, 2011 प्रकाशित किए गए थे, जिन्हें समय-समय पर संशोधित किया गया। इन नियमों ने देश में जनित प्लास्टिक अपशिष्ट के प्रबंध के लिए एक नियामक ढ़ांचा उपलब्ध कराया;

और इन नियमों को अधिक कारगर ढंग से लागू करने और प्लास्टिक अपशिष्ट को न्यूनतम करने, स्रोत पर पृथक्करण, पुन: चक्रण पर बल देने के लिए घरों से अथवा इसके जनन के अन्य किसी स्रोत से अथवा मध्यवर्ती सामग्री पुन: प्राप्ति सुविधा से प्लास्टिक अपशिष्ट के टुकड़ों के संग्रहण में अपशिष्ट बीनने वालों, पुन: चक्रकों और अपशिष्ट संसाधकों को शामिल किया और अपशिष्ट प्रबंध प्रणाली की दीर्घकालिकता के लिए प्रदूषकों के भुगतान करने का सिद्धांत अपनाने के लिए केंद्रीय सरकार ने वर्तमान नियमों की समीक्षा की;

और पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 6, 8 और 25 द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए भारत सरकार, पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय द्वारा मसौदा नियम अर्थात प्लास्टिक अपशिष्ट प्रबंध नियम, 2015 भारत के राजपत्र में सा.का.नि.423(अ), तारीख 25 मई, 2015 के तहत प्रकाशित कराए गए थे जिसमें जिस तारीख को उक्त अधिसूचना वाले राजपत्र की प्रतियां जनता को उपलब्ध कराई गई थीं उससे 60 दिन की अवधि समाप्त होने से पूर्व इनसे प्रभावित होने वाले संभावित सभी व्यक्तियों से आपत्तियां और सुझाव आमंत्रित किए गए थे;

और उक्त राजपत्र की प्रतियां 25 मई, 2015 को जनता को उपलब्ध करा दी गई थीं।

और उक्त मसौदा नियमों के संबंध में जनता से उक्त अवधि के अंदर प्राप्त आपत्तियों और सुझावों पर केंद्रीय सरकार द्वारा विधिवत विचार किया गया है;

अब, इसलिए, पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 की 29) की धारा 3, 6 और 25 द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए तथा प्लास्टिक अपशिष्ट (प्रबंध और प्रहस्तन) नियम, 2011 का अधिक्रमण करते हुए, उन बातों को छोड़कर जो उक्त अधिक्रमण से पूर्व की गई है अथवा जिनका विलोप किया गया है, केंद्रीय सरकार एतद्वारा निम्नलिखित नियम बनाती है, अर्थात् :-

1. संक्षिप्त नाम और प्रारंभ.- (1) इन नियमों का संक्षिप्त नाम अपशिष्ट प्लास्टिक नियम, 2016 है।

(2) इन नियमों में उपबंध के सिवाए वे राजपत्र में अपने प्रकाशन की तारीख से प्रवृत्त होंगे।

2. लागू होना.-

(1) ये नियम प्रत्येक अपशिष्ट उत्पादक, शहरी स्थानीय निकाय, ग्राम पंचायत विनिर्माता और उत्पादक को लागू होंगे।

(2) नियम 4 केंद्रीय सरकार द्वारा अधिसूचित निर्यात के आदेश के लिए अपने उत्पाद के विनिर्माण के लिए निर्यातोन्मुख इकाइयों या विशेष आर्थिक जोन की इकाइयों पर लागू नहीं होगा: परन्तु यह छूट गुटका, तम्बाकू और पान मसाला के पैकेजिंग में लगी इकाइयों और किसी अधिशेष या निराकृत, अवशेष और इसी प्रकार के अन्य उत्पादों पर भी लागू नहीं होगी।

3. परिभाषाएं.- इन नियमों में जब तक कि संदर्भ से अन्यथा अपेक्षित न हो.-

(क) **"अधिनियम"** से पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) अभिप्रेत है;

(ख) **"ब्रांड स्वामी"** ऐसे व्यक्ति या कंपनी से अभिप्रेत है जो किसी पंजीकृत ब्रांड लेबल के तहत कोई वस्तु बेचता है।

(ग) **"कैरी बैग"** से प्लास्टिक सामग्री या कंपोस्ट योज्य प्लास्टिक सामग्री से बनाया गया, ले जाने या वस्तुएं तैयार करने के प्रयोजन के लिए प्रयुक्त बैग अभिप्रेत है जिसमें स्वत: ले जाने की विशिष्टता है किन्तु इसमें ऐसा बैग सम्मिलित नहीं है जो ऐसी पैकेजिंग गठित करता है या अभिन्न भाग बनता है जिसमें माल को उपयोग के पूर्व सील किया जाता है;

(घ) **"वस्तु से"** ऐसा मूर्त मद अभिप्रेत है जिसे खरीदा या बेचा जा सके और इसमें सभी पण्य माल या सौदा सम्मिलित है;

(ङ) **"कंपोस्ट योज्य प्लास्टिक"** से ऐसी प्लास्टिक अभिप्रेत है जो जैविकीय प्रक्रियाओं द्वारा विघटनीय होने के दौरान कार्बन-डाई-आक्साइड, जल, अकार्बनिक यौगिकों को कंपोस्ट करती है और अन्य ज्ञात कंपोस्ट योज्य सामग्रियों के साथ जैव भार की समरूप दर है और जो दृश्य, विशेषणीय या विषाक्त अपशिष्ट नहीं छोड़ती है;

(च) **"सहमति"** से जल (प्रदूषण निवारण तथा नियंत्रण) अधिनियम, 1974 (1974 का 6) और वायु (प्रदूषण निवारण या नियंत्रण) अधिनियम, 1981 (1981 का 14) के अधीन संबद्ध राज्य प्रदूषण नियुत्रण बोर्ड या प्रदूषण नियंनियंत्रण समिति से स्थापित करने की सहमति और उसे चलाने की सहमति अभिप्रेत है;

(छ) **"विघटन"** से किसी सामग्री का बहुत छोटे भागों में भौतिक रूपों में भंजन अभिप्रेत है;

(ज) **"विस्तारित उत्पादक दायित्व"** से इसके जीवन तक उत्पाद के पर्यावर्णीय रूप से सुदृढ़ के लिए उत्पादक का दायित्व अभिप्रेत है;

(झ) **"खाद्य पदार्थ"** से द्रव, चूर्ण, ठोस या अर्ध ठोस रूप में खाने के लिए तैयार खाद्य पदार्थ, फास्ट फूड, प्रसंस्कृत या पकाए हुए खाद्य पदार्थ अभिप्रेत हैं;

(ञ) **"सुविधा"** से प्लास्टिक अपशिष्ट के एकत्रण, भंडारण, पुन: चक्रीकरण, प्रसंस्करण और निपटान के लिए उपयोग किए जाने वाला परिसर अभिप्रेत है;

(ट) **"आयातकर्ता"** से ऐसा व्यक्ति अभिप्रेत है जो आयात करता है या करने का इरादा रखता है और जिसके पास आयात-निर्यात करने का लाइसेंस है, जब तक उसे अन्यथा विशेष रूप से छूट नहीं दी गई हो;

(ठ) **"संस्थागत अपशिष्ट जनित्र"** से केन्द्रीय सरकारी विभागी, राज्य सरकारी विभाग, पब्लिक या प्राइवेट सैक्टर कंपनियां, अस्पताल, स्कूल, महाविद्यालय, विश्वविद्यालय या शिक्षा के अन्य स्थल, संगठन, अकादमी, होटल, रेस्तरां, मॉल और शॉपिंग परिसरों द्वारा अधिकृत भवन जैसे संस्थागत भवनों का अधिभोगी अभिप्रेत है और सम्मिलित है;

(ङ) **"विनिर्माता"** से उत्पादक द्वारा कच्ची सामग्री के रूप में प्रयुक्त की जाने वाली प्लास्टिक की कच्ची सामग्री के उत्पादन में लगा व्यक्ति या इकाई या अभिकरण अभिप्रेत है जो सम्मिलित है;

(ढ) **"बहुस्तरीय पैकेजिंग"** के लिए प्रयुक्त या प्रयुक्त की जाने वाली कोई सामग्री अभिप्रेत है और कागज, काज बोर्ड, बहुलक्ष्य सामग्रियां, धात्विक सतहों या एल्युमिनियम पन्नियां जो या तो लेमिनेट के रूप में या सह-बहिर्वेधन रूप में जैसे सामग्री के एक से अधिक सतह का संयोजन मुख्य संघटकों के रूप में प्लास्टिक का कम से एम स्तर रखती है;

(ण) **"प्लास्टिक"** से ऐसी सामग्री अभिप्रेत है जिसमें पोलीथाइलीन टेरेफेथेलेट, उच्च घनत्व पोलीथाइलीन, विनाइल, कम घनत्व पोलीथाइलीन, पोलीप्रोपीलीन, पोलीस्टाइरीन रेसिन, एक्रीलोनीट्रीइलीन बूटाडीन स्टाइरिन जैसी बहु सामग्री, पोलीफिनाइलीन आक्साइड, पोलीकार्बोनेट, पोलीबूटीलीन टेरेफिथालेट जैसी उच्च पालिमर के आवश्यक तत्व अनतर्विष्ट हों;

(त) **"प्लास्टिक चद्दर"** के प्लास्टिक चद्दर से अभिप्रेत है प्लास्टिक से बनी चद्दर;

(थ) **"प्लास्टिक अपशिष्ट"** से ऐसे किसी प्लास्टिक से अभिप्रेत है जिसे उपयोग के पश्चात या आशयित उपयोग के पश्चात फेंक दिया जाता है;

(द) **"विहित प्राधिकारी"** से नियम 12 में विनिर्दिष्ट प्राधिकारी अभिप्रेत है;

(ध) **"उत्पादक"** से कैरी बैग या बहुतस्तरीय पैकेजिंग या प्लास्टिक शीट या जैसे के विनिर्माण या आयात में लगा व्यक्ति अभिप्रेत है और प्लास्टिक शीट या जैसे या प्लास्टिक शीट के बनाए गए कवर या वस्तु की पैकेजिंग या ढ़कने के लिए बहुस्तरीय पैकेजिंग का उपयोग कर रहे उद्योग या व्यक्ति सम्मिलित हैं;

(न) **"पुन: चक्रीकरण"** नए उत्पाद उत्पादित करने के लिए पृथक्कृत प्लास्टिक अपशिष्ट को नए उत्पाद या कच्ची सामग्री में रूपान्तरित करने की प्रक्रिया से अभिप्रेत है;

(प) **"रजिस्ट्रीकरण"** से यथास्थिति, राज्य प्रदूषण नियंत्रण बोर्ड या संबद्ध प्रदूषण नियंत्रण समिति में रजिस्ट्रीकृत अभिप्रेत है;

(फ) **"पथ विक्रेता"** का वही अर्थ होगा जो पथ विक्रेता (आजीविका का संरक्षण और पथ विक्रय का विनियमन) अधिनियम, 2014 (2014 का 7) की धारा 2 की उपधारा (1) के खंड (1) में है;

(ब) **"शहरी स्थानीय निकाय"** से नगर निगम, म्युनिसिपलिटी, नगरपालिका, नगर निगम, नगर पंचायत, नगरपालिका परिषद जैसे विभिन्न नामों वाले शहरी स्थानीय निकाय अभिप्रेत हैं और जिसके अंतर्गत अधिसूचित क्षेत्र समिति (एनएसी) या सुसंगत कानूनों के अधीन गठित कोई अन्य स्थानीय निकाय और जहां प्लास्टिक अपशिष्ट का प्रबंध ऐसे अभिकरण को सौंपा गया है, सम्मिलित हैं;

(भ) **"अप्रयुक्त प्लास्टिक"** से ऐसी प्लास्टिक सामग्री अभिप्रेत है जिसका पहले उपयोग नहीं किया गया है या रद्दी या अपशिष्ट के साथ भी सम्मिश्रित नहीं किया गया है;

(म) **"अपशिष्ट जनित्र"** से प्रत्येक व्यक्ति या व्यक्तियों का समूह या संस्था, भारतीय रेल, विमानपत्तन, बंदरगाह और रक्षा कन्टूनमेंट जो अपशिष्ट प्लास्टिक पैदा करते हैं, सहित रिहायसी और वाणिज्यिक स्थापना अभिप्रेत है और सम्मिलित है;

(य) **"अपशिष्ट प्रबंध"** से प्लास्टिक अपशिष्ट का पर्यावरण की दृष्टि से सुरक्षित पद्धति से एकत्रण, भंडारण, परिवहन, पुन: उपयोग, पुन: प्राप्ति, पुन:चक्रण, कंपोस्टिंग या व्ययन अभिप्रेत है;

(र) **"अपशिष्ट चुनने वाले"** से पुन:चक्रण योग्य प्लास्टिक अपशिष्ट के चुनने में स्वैच्छिक रूप से लगे या प्राधिकृत किए गए व्यक्ति या एजेंसियां, व्यक्तियों का समूह अभिप्रेत है;

4. शर्तें.-

(1) कैरी बैग, प्लास्टिक शीट या इसी प्रकार या प्लास्टिक शीट या बहुस्तरीय पैकेजिंग के बने आवरण का विनिर्माण, आयात, भंडारण, वितरण, विक्रय और उपयोग के अनुक्रम दौरान निम्नलिखित शर्तें पूरी की जाएंगी, अर्थात :-

(क) कैरी बैग और प्लास्टिक पैकेजिंग या तो प्राकृतिक रंग में होंगे जो किसी मिलाए गए रंजक से रहित है या केवल उन्हीं रंजकों और रंगकों का उपयोग कर बनाए गए हैं जो समय-समय पर यथा-संशोधित "खाद्य पदार्थों, भेषजीय

पदार्थों और पीने के पानी के संपर्क में आने वाली प्लास्टिकों के उपयोग के लिए रंजकों और रंगकों की सूची" नामक शीर्षक से भारतीय मानक: आईएस 9833:1981 के अनुरूप हैं ;

(ख) पुन:चक्रित प्लास्टिक से बने कैरी बैग या पुन:चक्रित प्लास्टिक से बने उत्पादों का उपयोग खाने या पीने के लिए तैयार खाद्य सामग्री का भंडार करने, वहन करने, वितरण करने या पैकेजिंग करने के लिए नहीं किया जाएगा;

(ग) अप्रयुक्त या पुन:चक्रित प्लास्टिक के बने किसी कैरी बैग की मोटाई में पचास माइक्रोन्स से कम नहीं होगी;

(घ) प्लास्टिक शीट या इसी प्रकार, जो बहुस्तरीय पैकेजिंग और वस्तु की पैकेजिंग या लपेटने के लिए प्रयुक्त प्लास्टिक शीट के बने कवर का अभिन्न भाग नहीं है, की मोटाई पचास माइक्रोन्स से कम नहीं होगी, वहां छोड़कर जहां ऐसी प्लास्टिक शीट उत्पाद के कार्यरण में बाधक हो;

(ङ) विनिर्माता संबद्ध राज्य प्रदूषण नियंत्रण बोर्ड या प्रदूषण नियंत्रण समिति से विधिमान्य रजिस्ट्रीकरण न रखने वाले उत्पादक को कच्ची सामग्री के रूप में प्रयुक्त होने वाली प्लास्टिक को न बेचेगा या न उपलब्ध कराएगा या न व्यवस्था करेगा;

(च) गुटखा, तम्बाकू और पान मसाला के भंडारण, पैकिंग या बिक्री हेतु प्लास्टिक सामग्री युक्त सैशे का उपयोग नहीं किया जाएगा;

(छ) प्लास्टिक अपशिष्ट का पुन: चक्रण समय-समय पर यथा संशोधित भारतीय मानक के प्लास्टिक के पुन:चक्रण के लिए मार्गदर्शन नामक विनिर्देश भा.मा.14539:1998 के अनुरूप होगा;

(ज) मोटाई का प्रावधान कंपोस्ट योज्य प्लास्टिक से बने कैरी बैग पर लागू नहीं होगा। कंपोस्ट योज्य प्लास्टिक से बने कैरी बैग समय-समय यथा संशोधित कंपोस्ट योज्य प्लास्टिक के लिए विनिर्देश नामक भारतीय मानक आईएस या आईएसओ 17088:2008 के अनुरूप होंगे। कंपोस्ट योज्य कैरी बैग के विनिर्माता या विक्रेता विपणन या बिक्री करने से पूर्व केन्द्रीय प्रदूषण नियंत्रण बोर्ड से प्रमाण पत्र प्राप्त करेंगे;

(झ) विनायल एसिटेट-मलेइक एसिड-विनायल क्लोराइड कोपॉलिमर सहित किसी भी प्रकार की प्लास्टिक सामग्री का उपयोग किसी पैकेज में सभी प्रकार के गुटका, पान मसाला और तम्बाकू के पैकेजिंग के लिए नहीं किया जाएगा।

5. प्लास्टिक अपशिष्ट प्रबंध.-

(1) शहरी स्थानीय निकायों द्वारा अपने संबद्ध अधिकारिता में प्लास्टिक अपशिष्ट प्रबंध इस प्रकार होगा :-

(क) ऐसा प्लास्टिक अपशिष्ट जिसे पुन:चक्रित किया जा सकता हो, को रजिस्ट्रीकृत प्लास्टिक अपशिष्टि पुन:चक्रक को पहुंचाया जाएगा और प्लास्टिक का पुन:चक्रण समय-समय पर यथा-संशोधित पुन:चक्रण के लिए दिशा-निर्देश नामक भारतीय मानक : आईएस 14534:1998 के अनुसार किया जाएगा;

(ख) शहरी स्थानीय निकाय प्लास्टिक अपशिष्ट (प्रधानत: ऐसे प्लास्टिक अपशिष्ट का जिसका पुन:चक्रीकरण नहीं किया जा सकता) के उपयोग को भारतीय रोड कांग्रेस दिशा-निर्देशों के अनुसार सड़क निर्माण करने या ऊर्जा पुन: प्राप्त करने या वेस्ट टु ऑयल आदि हेतु करने को प्रोत्साहित करेंगी। इन प्रौद्योगिकियों के लिए निर्धारित प्राधिकरण द्वारा विनिर्दिष्ट मानकों और प्रदूषण नियंत्रण मानदंडों का पालन किया जाएगा।

(ग) तापस्थायी प्लास्टिक अपशिष्ट का प्रसंस्करण और व्ययन केन्द्रीय प्रदूषण नियंत्रण बोर्ड द्वारा समय-समय पर जारी मार्गदर्शक सिद्धांतों के अनुसार किया जाएगा;

(घ) प्लास्टिक अपशिष्ट के पुन:चक्रण या प्रसंस्करण की सुविधाओं के अक्रिय का व्ययन ठोस अपशिष्ट प्रबंध नियम, 2000 के अनुपालन में या समय-समय पर संशोधन के अनुसार किया जाएगा।

6. स्थानीय निकाय का दायित्व.-

(1) प्रत्येक स्थानीय निकाय स्वयं या अभिकरण या उत्पादक लगाकर प्लास्टिक अपशिष्ट के पृथक्करण या संग्रहण, भंडारण, परिवहन, प्रसंस्करण और व्ययन की अवसंरचना को विकसित करने और स्थापना के लिए उत्तरदायी होगा;

(2) स्थानीय निकाय अपशिष्ट प्रबंध प्रणाली की स्थापना, प्रचालन और समन्वय के लिए तथा सहयोजित कृत्यों के निर्वहन के लिए उत्तरदायी होगा, अर्थात्;

(क) प्लास्टिक अपशिष्ट के संग्रहण, भंडारण, पृथक्करण, परिवहन, प्रसंस्करण और व्ययन को सुनिश्चित करना;

(ख) यह सुनिश्चित करना कि इस प्रक्रिया के दौरान पर्यावरण को कोई हानि न हो;

(ग) पुन:चक्रण करने वाले लोगों के प्रति पुन:चक्रण योग्य प्लास्टिक अपशिष्ट भाग के सरणीकरण को सुनिश्चित करना;

(घ) केन्द्रीय प्रदूषण नियंत्रण बोर्ड द्वारा जारी मार्ग निर्देशक सिद्धांतों के अनुसार प्लास्टिक अपशिष्ट के गैर पुन:चक्रण योग्य भाग के प्रसंस्करण और व्ययन को सुनिश्चित करना;

(ङ) सभी पणधारियों में उनके उत्तरदायित्व के लिए जागृति पैदा करना;

(च) अपशिष्ट चुनने वालों के साथ कार्य कर रहे सिविल सोसायटी या समूहों को लगाना; और

(छ) यह सुनिश्चित करना कि प्लास्टिक अपशिष्ट को खुले में न जलाया जाए।

(3) प्लास्टिक अपशिष्ट प्रबंध के लिए प्रणाली के गठन के लिए स्थानीय निकाय उत्पादकों की सहायता लेगा और इन नियमों को भारत के राजपत्र में अंतिम प्रकाशन की तारीख से एक वर्ष के भीतर ऐसी प्रणाली का गठन किया जाएगा।

(4) स्थानीय निकाय इन नियमों के प्रावधानों को शामिल करते हुए उप-नियम बनाएगा।

7. ग्राम पंचायतों का दायित्व.-

(1) प्रत्येक ग्राम पंचायत स्वयं या अभिकरण के माध्यम से अपने नियंत्रण के अधीन ग्रामीण क्षेत्र में अपशिष्ट प्रबंधन के लिए और सहयोजित कृत्यों के अनुपालन के लिए स्थापना, प्रचालन और समन्वय करेगा अर्थात.-

(क) प्लास्टिक अपशिष्ट का संग्रहण, भंडारण, पृथक्करण, परिवहन और विधिमान्य रजिस्ट्रीकरण रखने वाले पुन:चक्रण करने वाले लोगों के प्रति पुन:चक्रण योग्य प्लास्टिक अपशिष्ट का सरणीकरण सुनिश्चित करना; यह सुनिश्चित करना कि इस प्रक्रिया के दौरान पर्यावरण को कोई हानि न हो;

(ख) सभी पणधारियों में उनके उत्तरदायित्व के लिए जागृति पैदा करना;

(ग) यह सुनिश्चित करना कि प्लास्टिक अपशिष्ट को खुले में न जलाया जाए।

8. अपशिष्ट जनक का उत्तरदायित्व.-

(1) अपशिष्ट जनक.-

(क) समय-समय पर यथा संशोधित ठोस अपशिष्ट प्रबंध नियम, 2000 के अनुसार प्लास्टिक अपशिष्ट के जनन को कम करने और स्त्रोत पर प्लास्टिक अपशिष्ट को पृथक करने के कदम उठाएगा।

(ख) प्लास्टिक अपशिष्ट को न बिखरने देगा और स्रोत पर अपशिष्ट का पृथक भंडारण सुनिश्चित करेगा तथा पृथक अपशिष्ट को शहरी स्थायी निकायों या ग्राम पंचायत या उनके द्वारा नियुक्त एजेंसियों या अपशिष्ट चुनने वालों, रजिस्ट्रीकृत पुन:चक्रणकर्ताओं या अपशिष्ट संग्रहण अभिकरणों को सौंपेगा;

(2) प्लास्टिक अपशिष्ट के सभी संस्थागत जनक उनके द्वारा जनित अपशिष्ट का पृथक्करण और भंडारण इस अधिनियम या इसके बाद संशोधित अधिनियम के तहत का.आ.908(अ) तारीख 25 सितंबर, 2000 द्वारा अधिसूचित म्युनिसिपल ठोस अपशिष्ट (प्रबंधन और प्रहस्तन) नियम, 2000 के अनुसार करेंगे और पृथक्कृत अपशिष्टकों को स्वयं के या प्राधिकृत अपशिष्ट अभिकरण के माध्यम से प्राधिकृत अपशिष्ट प्रसंस्करण या व्ययन सुविधा या निक्षेपण केन्द्रों को सौंपेंगे।

(3) सभी अपशिष्ट जनक ऐसी उपयोक्ता फीस या प्रभार अदा करेंगे जो अपशिष्ट संग्रहण या उसकी सुविधा के प्रचालन आदि जैसे प्लास्टिक अपशिष्ट प्रबंध के लिए स्थानीय निकायों की उपविधियों में विनिर्दिष्ट हो;

(4) खुली जगह में आयोजन की व्यवस्था करने वाला प्रत्येक उत्तरदायी व्यक्ति जिसमें प्लास्टिक या बहुस्तरीय पैकेजिंग में खाद्य सामग्री की सेवा अंतर्वलित है, ऐसे आयोजनों के दौरान जनित अपशिष्ट का पृथक्करण और प्रबंधन इस अधिनियम या इसके बाद संशोधित अधिनियम के तहत का.आ.908(अ) तारीख 25 सितंबर, 2000 द्वारा अधिसूचित म्युनिसिपल ठोस अपशिष्ट (प्रबंधन और प्रहस्तन) नियम, 2000 के अनुसार करेगा।

9. उत्पादकों, आयातकर्ताओं और ब्रांड स्वामियों का दायित्व.-

(1) उत्पादक इन नियमों के प्रकाशन की तारीख से छह मास की अवधि के भीतर व्यक्तिगत या समूहिक रूप से अपने निजी वितरण चैनल या संबद्ध स्थानीय निकाय के माध्यम से विस्तारित उत्पादक दायित्व पर आधारित अपशिष्ट संग्रहण प्रणाली के लिए राज्य शहरी विकास विभाग को सम्मिलित करते हुए रूपरेखा तैयार करेगा।

(2) उपयोग में लाए गए बहुस्तरीय प्लास्टिक शैशे या पाउचों या पैकेजिंग के संग्रहण का प्रमुख दायित्व उन उत्पादकों, आयातकर्ताओं और ब्राउंड स्वामियों का होगा जो बाजार में उत्पाद को पेश करते हैं। उन्हें अपने उत्पादों के कारण जनित प्लास्टिक अपशिष्ट को वापस संग्रह करने की प्रणाली स्थापित करने की जरूरत है। संग्रह करने की यह योजना स्थापित करने या प्रचालन या नवीकरण के लिए सहमति हेतु आवेदन करते समय राज्य प्रदूषण नियंत्रण बोर्ड को प्रस्तुत करनी होगी। जिन ब्रांड स्वामियों की सहमति का नवीकरण इन नियमों की अधिसूचना से पहले कर दिया गया है वे इन नियमों की अधिसूचना की तारीख से एक वर्ष के अंदर उक्त योजना प्रस्तुत कर देंगे और उसके दो वर्ष बाद लागू कर देंगे।

(3) पुन:चक्रीकरण न की जा सकने योग्य बहुस्तरीय पैकेजिंग का विनिर्माण एवं उपयोग, यदि कोई हो, दो वर्ष में बंद कर दिया जाएगा।

(4) उत्पादक राजपत्र में इन नियमों के अंतिम प्रकाशन की तारीख से तीन मास की अवधि के भीतर रजिस्ट्रीकरण की मंजूरी के लिए राज्यों या संबद्ध संघ राज्य क्षेत्रों के प्रशासन के यथास्थिति प्रदूषण नियंत्रण बोर्ड या प्रदूषण नियंत्रण समिति को आवेदन करेगा।

(5) कोई उत्पादक राजपत्र में इन नियमों के अंतिम प्रकाशन की तारीख से एक वर्ष की अवधि की समाप्ति पर या इसके पश्चात संबद्ध राज्य प्रदूषण नियंत्रण बोर्ड या प्रदूषण नियंत्रण समितियों से रजिस्ट्रीकरण के बिना वस्तुओं के पैकेजिंग के लिए किसी प्लास्टिक या बहुस्तरीय पैकेजिंग का विनिर्माण या उपयोग नहीं करेगा।

(6) प्रत्येक उत्पादक कैरी बैग या प्लास्टिक शीट या इसी प्रकार या प्लास्टिक शीट या बहुस्तरीय पैकेजिंग के बने कवर के विनिर्माण के लिए कच्ची सामग्री के रूप में प्रयुक्त प्लास्टिक की आपूर्ति में लगे व्यक्ति के ब्यौरों के अभिलेख बनाए रखेगा।

10. कंपोस्ट योज्य प्लास्टिक सामग्रियों के लिए नयाचार.- प्लास्टिक सामग्री के अविक्रमित की डिग्री और विघटन की डिग्री का निर्धारण, इन नियमों की अनुसूची-1 में सूचीबद्ध भारतीय मानकों के नयाचारों के अनुसार होगा।

11. मार्का या लेबल लगाना.- (1) प्रत्येक प्लास्टिक कैरी बैग और बहुस्तरीय पैकेजिंग पर अंग्रेजी में निम्नलिखित जानकारी मुद्रित की जाएगी, अर्थात् :-

(क) कैरी बैग की दशा में विनिर्माणकर्ता का नाम, उसका रजिस्ट्रीकरण संख्या और मोटाई; और

(ख) बहुस्तरीय पैकेजिंग की दशा में विनिर्माणकर्ता का नाम और उसका रजिस्ट्रीकरण संख्या।

(ग) कंपोस्ट योज्य प्लास्टिक से बने कैरी बैग की दशा में नाम और प्रमाणपत्र सं. [नियम 4(ज)]।

(2) प्रत्येक पुन:चक्रित कैरी बैग पर निम्नलिखित रूप में यथादर्शित "पुन:चक्रित" लेबल या चिन्ह होगा और भारतीय मानके के समय-समय पर यथा संशोधित पुन:चक्रित प्लास्टिक के लिए मार्गदर्शक नामक विनिर्देश भा.मा.14534:1998 के अनुसार होगा;

टिप्पण : पैट-पोलीथाइलिन टेरीफैथेलेट, एचडीईपी-उच्च डेंसिटी पोलीथाइलिन, वी-विनाइल (पीवीसी), एलडीपीई - निम्न डेंसिटी पोलीथाइलिन, पीपी-पोलीप्रोपिलिन, पीएस पोलीस्टायरिन और अन्य से अभिप्रेत सभी अन्य राल और बहुसामग्रियां हैं जैसे एबीएस (एक्रीलोनिट्राइल बूटाडिन स्टायरिन), पीपीओ (पोलीफेननाइलिन आक्साइड), पीपी (पोलीकार्बोनेट), पीवीटी (पोलीबूटीलेन पेरीफेलेट) आदि।

(3) कंपोस्ट योज्य प्लास्टिकों से बने प्रत्येक कैरी बैग पर कंपोस्ट योज्य का लेबल लगा होगा और भारतीय मानक के कंपोस्ट योज्य प्लास्टिक के लिए विनिर्देश नामक विनिर्देश भा.मा./भा.मा.स.17088:2008 के अनुरूप होगा।

12. विहित प्राधिकारी.- (1) किसी संघ राज्य क्षेत्र की बाबत राज्य प्रदूषण नियंत्रण बोर्ड या प्रदूषण नियंत्रण समिति रजिस्ट्रीकरण, प्लास्टिक उत्पादों और बहुस्तरीय पैकेजिंग के विनिर्माण, अपशिष्ट प्लास्टिक के प्रसंस्करण और व्ययन से संबंधित इन नियमों के उपबंधों को प्रवृत्त करने के लिए प्राधिकारी होगा;

(2) राज्य या संघ राज्य क्षेत्र के शहरी विभाग का संबद्ध भारसाधक सचिव अपशिष्ट जनक द्वारा अपशिष्ट प्रबंधन, प्लास्टिक कैरी बैग, प्लास्टिक शीट या इसी प्रकार के प्लास्टिक शीटों और बहुस्तरीय पैकेजिंग से बने कवर के उपयाग से संबंधित इन नियमों के उपबंधों को प्रवृत्त करने के लिए प्राधिकारी होगा;

(3) संबद्ध ग्राम पंचायत राज्य सा संघ राज्य क्षेत्र के ग्रामीण क्षेत्रों में अपशिष्ट जनक द्वारा अपशिष्ट प्रबंधन, प्लास्टिक कैरी बैग, प्लास्टिक शीट या इसी प्रकार के प्लास्टिक शीटों और बहुस्तरीय पैकेजिंग से बने कवर के उपयोग से संबंधित इन नियमों के उपबंधों को प्रवृत्त करने के लिए प्राधिकारी होगा;

(4) उप-नियम (1) से (3) में निर्दिष्ट प्राधिकारी इन नियमों के उपबंधों के प्रवर्तन में संबद्ध जिले की अधिकारिता की राज्य क्षेत्र की सीमाओं के भीतर जिला मजिस्ट्रेट या उपायुक्त की सहायता लेगा।

13. उत्पादक, पुन:चक्रणकर्ता और विनिर्माणकर्ता का रजिस्ट्रीकरण.- (1) कोई व्यक्ति कैरी बैगों या पुन:चक्रित प्लास्टिक बैगों और बहुस्तरीय प्लास्टिकों का विनिर्माण तब तक नहीं करेगा जब तक कि उसने उत्पादन के प्रारंभ से पूर्व यथास्थिति राज्य प्रदूषण नियंत्रण बोर्ड या संघ राज्य क्षेत्र की प्रदूषण नियंत्रण समिति से रजिस्ट्रीकरण प्रमाणपत्र अभिप्राप्त न हो गया हो;

(2) प्रत्येक उत्पादनकर्ता रजिस्ट्रीकरण के लिए या रजिस्ट्रीकरण के नवीकरण के लिए राज्य प्रदूषण नियंत्रण बोर्ड या संघ राज्य क्षेत्र की प्रदूषण नियंत्रण समिति को उपाबद्ध प्ररूप 1 का प्रयोग करते हुए आवेदन करेगा।

(3) ऐसा कोई व्यक्ति जो कैरी बैग और बहुस्तरीय प्लास्टिकों या प्लास्टिक अपशिष्ट का पुन:चक्रण करता है या पुन:चक्रण करने के लिए प्रस्ताव करता है, उपाबद्ध प्ररूप 2 का प्रयोग करते हुए पुन:चक्रण यूनिट के लिए रजिस्ट्रीकरण प्रदान करने के लिए या रजिस्ट्रीकरण का नवीकरण करने के लिए राज्य प्रदूषण नियंत्रण बोर्ड या प्रदूषण नियंत्रण समिति को आवेदन करेगा।

(4) उत्पादक द्वारा कच्ची सामग्री के रूप में प्रयुक्त की जाने वाली प्लास्टिक के विनिर्माण में लगे प्रत्येक विनिर्माता प्ररूप 3 में रजिस्ट्रीकरण की मंजूरी या रजिस्ट्रीकरण के नवीकरण के लिए राज्य प्रदूषण नियंत्रण बोर्ड या संबद्ध संघ राज्य क्षेत्र की प्रदूषण नियंत्रण समिति को आवेदन करेगा।

(5) राज्य प्रदूषण नियंत्रण बोर्ड और प्रदूषण नियंत्रण समिति विनिर्माण या पुन:चक्रण यूनिटों के लिए कोई रजिस्ट्रीकरण तब तक जारी नहीं करेगी या उसका नवीकरण नहीं करेगी जब तक कि यूनिट, जल (प्रदूषण निवारण तथा नियंत्रण) अधिनियम, 1974 (1974 का 6) और वायु (प्रदूषण निवारण तथा नियंत्रण) अधिनियम, 1981 (1981 का 14) के अधीन कोई विधिमान्य सहमति नहीं रखती हो और जिला उद्योग केन्द्र या इस संबंध में प्राधिकृत किसी अन्य सरकारी अभिकरण द्वारा जारी रजिस्ट्रीकरण का प्रमाणपत्र न रखती हो।

(6) राज्य प्रदूषण नियंत्रण बोर्ड और प्रदूषण नियंत्रण समिति उत्पादक के रजिस्ट्रीकरण का नवीकरण तब नहीं करेगा जब तक उत्पादक प्लास्टिक अपशिष्ट प्रणाली की स्थापना के लिए संबद्ध राज्य या संघ राज्य क्षेत्र के शहरी विकास के भारसाधक सचिव द्वारा पृष्ठांकित कार्य योजना न रखता हो।

(7) उपनियम (3) के अंतर्गत प्लास्टिक अपशिष्ट के पुन:चक्रण या प्रसंस्करण के रजिस्ट्रीकरण के लिए सभी प्रकार से पूर्ण आवेदन की प्राप्ति पर राज्य प्रदूषण नियंत्रण बोर्ड ऐसी जांच करने के पश्चात जो वह आवश्यक समझे और यह समाधान हो जाने पर कि आवेदक के पास समुचित सुविधाएं तकनीकी योग्यताएं और प्लास्टिक अपशिष्ट से

सुक्षित रूप से निपटने के लिए उपकरण हैं, ऐसी शर्तों के पूरा होने पर आवेदक को रजिस्ट्रीकरण मंजूर कर सकेगा जो रजिस्ट्रीकरण के निबंधनों में अभिकथित की जाएं।

(8) प्रत्येक राज्य प्रदूषण नियंत्रण बोर्ड या प्रदूषण नियंत्रण समिति, सभी प्रकार से पूर्ण आवेदन की प्राप्ति के नब्बे दिनों के भीतर रजिस्ट्रीकरण प्रदान करने हेतु विनिश्चय करेगा।

(9) इस नियम के अधीन अनुदत्त रजिस्ट्रीकरण जब तक कि वह विखंडित, निलंबित या रद्द नहीं कर दिया जाता है एक वर्ष की अवधि के लिए विधिमान्य होगा और बाद में उसे तीन वर्ष तक बढ़ाया जा सकता है।

(10) राज्य प्रदूषण नियंत्रण बोर्ड या प्रदूषण नियंत्रण समिति, रजिस्ट्रीकरण को उत्पादक या प्लास्टिक अपशिष्ट के पुन:चक्रण या प्रसंस्करण में लगे हुए व्यक्ति को सुनवाई का अवसर दिए बिना विखंडित, निलंबित या रद्द नहीं करेगी।

(11) रजिस्ट्रीकरण के नवीकरण के लिए प्रत्यक आवेदन, रजिस्ट्रीकरण प्रमाणपत्र की विधिमान्यता की समाप्ति से कम से कम एक सौ बीस दिन पूर्व किया जाएगा।

14. खुदरा विक्रेताओं और पथ विक्रेताओं का दायित्व.- (1) खुदरा विक्रेता या पथ विक्रेता उपभोक्ता को ऐसे कैरी बैग या प्लास्टिक शीट या बहुस्तरीय पैकेजिंग में वस्तु नहीं बेचेगा या उपलब्ध कराएगा जो इन नियमों के अधीन विहितानुसार विनिर्मित या लेबल लगे या चिन्हित नहीं है।

(2) प्लास्टिक कैरी बैग या बहुस्तरीय पैकेजिंग या प्लास्टिक शीट या इसी प्रकार या ऐसे प्लास्टिक शीट से बने जो इन नियमों के अनुसार विनिर्मित या लेबलित या चिन्हित नहीं है, में वस्तुओं को बेचने या उपलब्ध कराने वाला प्रत्येक खुदरा विक्रेता या पथ विक्रेता ऐसा जुर्माना देने का दायी होगा जो स्थानीय निकायों की विधियों में विनिर्दिष्ट हो।

15. कैरी बैगों की कीमत सुनिश्चित करना.- (1) जो दुकानदार और पथ विक्रेता किसी वस्तु को वितरित करने के लिए प्लास्टिक के कैरी बैग उपलब्ध कराना चाहते हैं उन्हें स्थानीय निकाय के पास पंजीकरण करना होगा। स्थानीय निकाय, भारत के राजपत्र में इन नियमों के प्रकाशित होने की तारीख से छह माह की अवधि के अंदर, चार हजार रुपये प्रतिमाह की दर से न्यूनतम अड़तालीस हजार रुपये का प्लास्टिक प्रबंधन शुल्क का भुगतान करने के बाद ऐसे पंजीकरण के लिए अपने राज्य के उपयुक्त कानून या उपनियमों के तहत अधिसूचना या आदेश के द्वारा प्रावधान करेगा। संबंधित स्थानीय निकाय उत्पादन या बिक्री क्षमता को ध्यान में रखते हुए अधिक प्लास्टिक अपशिष्ट प्रबंधन शुल्क निर्धारित कर सकता है। पंजीकृत दुकानदार प्रमुख स्थान पर प्रदर्शित करेगा कि प्लास्टिक कैरी बैग भुगतान करने पर दिए जाते हैं।

(2) वस्तुओं का वितरण करने के लिए प्लास्टिक कैरी बैग उपलब्ध कराने के लिए केवल पंजीकृत दुकानदार या पथ विक्रेता पात्र होंगे।

(3) शहरी स्थानीय निकाय कैरी बैगों के लिए उपभोक्ताओं द्वारा संदत रकम का अनन्यत: उपयोग अपनी अधिकारिताओं के भीतर अपशिष्ट प्रबंधन प्रणाली की संधार्यता के लिए करेगा।

16. राज्य स्तरीय मॉनीटरिंग समिति.- (1) राज्य सरकार या संघ राज्य क्षेत्र, इन नियमों के क्रियान्वयन के प्रभावी मॉनीटरिंग करने के प्रयोजन के लिए राज्य स्तरीय सलाहकार समिति का गठन करेगा जिसमें निम्नलिखित व्यक्ति होंगे, अर्थात :-

(क)	सचिव, शहरी विकास विभाग	-	अध्यक्ष
(ख)	राज्य पर्यावरण विभाग से निदेशक	-	सदस्य
(ग)	राज्य प्रदूषण नियंत्रण बोर्ड या प्रदूषण नियंत्रण समिति से सदस्य सचिव	-	सदस्य
(घ)	म्युनिसिपल कमीशनर	-	सदस्य
(ङ)	स्थानीय निकाय से एक विशेषज्ञ		सदस्य
(च)	गैर सरकारी संगठन से एक विशेषज्ञ जो अपशिष्ट प्रबंधन में शामिल हो	-	सदस्य
(छ)	कमीशनर वैल्यु ऐडेड टैक्स या उसका प्रतिनिधि	-	सदस्य
(ज)	बिक्री कर कमीशनर या अधिकारी	-	सदस्य
(झ)	प्लास्टिक संघ, ड्रग मॅन्युफैक्चरर एसोसिएशन, केमिकल मॅन्युफैक्चरर	-	सदस्य

एसोसिएशन का प्रतिनिधि

(ञ) उद्योग क्षेत्र से एक विशेषज्ञ - सदस्य

(ट) शिक्षा संस्था के क्षेत्र से एक विशेषज्ञ - सदस्य

(ठ) निदेशक, म्युनिसिवल प्रशासन - संयोजक

राज्य स्तरीय सलाहकार निकाय छह माह में कम से कम एक बार बैठक करेगा और यदि वह आवश्यक समझता है तो विशेषज्ञों को आमंत्रित कर सकेगा।

17. वार्षिक रिपोर्टें.- (1) प्लास्टिक अपशिष्ट के पुन:चक्रण या प्रसंस्करण में लगा प्रत्येक व्यक्ति प्ररूप 4 में वार्षिक रिपोर्ट्स तैयार करेगा और प्रत्येक वर्ष के 30 अप्रैल तक संबद्ध राज्य प्रदूषण नियंत्रण बोर्ड प्रदूषण नियंत्रण समिति की सूचना के अधीन संबद्ध शहरी स्थानीय निकाय को प्रस्तुत करेगा।

(2) प्रत्येक शहरी स्थानीय निकाय प्रत्येक वर्ष की 30 जून संबद्ध राज्य प्रदूषण नियंत्रण बोर्ड प्रदूषण नियंत्रण समिति की सूचना के अधीन शहरी विकास के संबद्ध भारसाधक सचिव को प्ररूप-5 में वार्षिक रिपोर्ट तैयार करेगा और प्रस्तुत करेगा।

(3) प्रत्येक राज्य प्रदूषण नियंत्रण बोर्ड या प्रदूषण समिति, प्रत्येक वर्ष 31 जुलाई तक इन नियमों के क्रियान्वयन पर प्ररूप-VI में वार्षिक रिपोर्ट तैयार करेगा और केन्द्रीय प्रदूषण नियंत्रण बोर्ड को प्रस्तुत करेगा।

(4) केन्द्रीय प्रदूषण नियंत्रण बोर्ड, प्लास्टिक अपशिष्टों के उपयोग और प्रबंधन पर समेकित एक वार्षिक रिपोर्ट तैयार करेगा और उसको प्रत्येक वर्ष 31 अगस्त से पूर्व अपनी सिफारिशों के साथ केन्द्रीय सरकार को अग्रेषित करेगा।

अनुसूची-I

(नियम 10 देखें)

1.	भा.मा./भा.मा.स.14851:1999 जलीय माध्यम से प्लास्टिक सामग्री की अंतिम (अल्टीमेट) ऑक्सी जैव विघटनीयता ज्ञात करना - बंद रेसपीरोमीटर में ऑक्सीजन की आवश्यकता मापन द्वारा पद्धति
2.	भा.मा./भा.मा.स.14852:1999 जलीय माध्यम में प्लास्टिक सामग्री की अंतिम (अल्टीमेट) ऑक्सी विघटनीयता ज्ञात करना - उत्पन्न कार्बन डाइऑक्साइड के विश्लेषण द्वारा पद्धति
3.	भा.मा./भा.मा.स.14853:2005 प्लास्टिक - जलीय तंत्र में प्लास्टिक सामग्री की अंतिम (अल्टीमेट) ऑक्सी जैव विघटनीयता ज्ञात करना - बायोगैस उत्पादन के मापन द्वारा पद्धति
4.	भा.मा./भा.मा.स.14855-1:2005 नियंत्रिक संघटक स्थितियों में प्लास्टिक सामग्री की अंतिम (अल्टीमेट) ऑक्सी जैव विघटनीयता ज्ञात करना - उत्पन्न कार्बन डाईऑक्साइड के विश्लेषण द्वारा पद्धति (भाग-1 सामान्य पद्धति)
5.	भा.मा./भा.मा.स.14855-2:2007 नियंत्रिक संघटक स्थितियों में प्लास्टिक सामग्री की अंतिम (अल्टीमेट) ऑक्सी जैव विघटनीयता ज्ञात करना - उत्पन्न कार्बन डाइऑक्साइड के विश्लेषण द्वारा पद्धति (भाग-2; प्रयोगशाला-स्केल परीक्षण में उत्पन्न कार्बन डाइऑक्साइड का भारात्मक मापन)
6.	भा.मा./भा.मा.स.15985:2004 प्लास्टिक - 4उच्च ठोसता की अनॉक्सी (एनोरोबिक) डाइजेशन स्थितियों में अंतिम (अल्टीमेट) अनॉक्सी (एनोरोबिक) जैव विघटनीयता एवं विघटन ज्ञात करना - निकली बायोगैस की विश्लेषण पद्धति
7.	भा.मा./भा.मा.स.16929:2002 प्लास्टिक - पायलट मापन परीक्षण में परिभाषित संघटक स्थितियों में प्लास्टिक सामग्री के विघटन का स्तर ज्ञात करना
8.	भा.मा./भा.मा.स.17556:2003 प्लास्टिक - रेसपीरोमीटर में ऑक्सीजन की आवश्यकता अथवा उत्पन्न कार्बन डाइऑक्साइड के मापन द्वारा मृदा में अंतिम (अल्टीमेट) ऑक्सी जैव विघटनीयता ज्ञात करना
9.	भा.मा./भा.मा.स.20200:2004 प्लास्टिक - प्रयोगशाला में अनुरूपी कंपोस्टिंग स्थितियों में प्लास्टिक सामग्रियों के विघटन का स्तर ज्ञात करना - स्केल परीक्षण

प्ररूप-I

[नियम 13(2) देखें]

उत्पादकों या ब्रांड स्वामियों के रजिस्ट्रीकरण के लिए आवेदन

प्रेषक .....

.....

..... (अधिष्ठाता का नाम और पूरा पता)

सेवा में,

सदस्य सचिव,

..... प्रदूषण नियंत्रण बोर्ड/प्रदूषण नियंत्रण समिति

.....

.....

महोदय,

मैं/हम प्लास्टिक अपशिष्ट (प्रबंधन) नियम, 2015 के नियम 9 के अधीन पंजीकरण के लिए आवेदन करता हूं/करते हैं।

I. उत्पादक

	भाग-क साधारण	
1. (क)	इकाई का नाम और अवस्थिति	
(ख)	इकाई का नाम	
(ग)	निम्नलिखित के विनिर्माण के लिए अपेक्षित पंजीकरण : (i) कैरी बैग [(क) पैट्रो आधारित, (ख) कंपोस्ट योज्य] (ii) बहुस्तरीय प्लास्टिक	
(घ)	विनिर्माण क्षमता	
(ड.)	नवीकरण की दशा में, पूर्व रजिस्ट्रीकरण संख्या और रजिस्ट्रीकरण की तारीख	
2.	क्या इकाई, राज्य सरकार/संघ राज्य क्षेत्र प्रशासन में जिला उद्योग केन्द्र में रजिस्ट्रीकरण है? यदि हां, तो प्रति संलग्न करें।	
3. (क)	परियोजना पर निवेशित कुल पूंजी	
(ख)	उत्पादन आरंभ करने का वर्ष	
4. (क)	उत्पादों और उप उत्पादों की सूची और मात्रा	
(ख)	प्रयुक्त कच्ची सामग्री की सूची और मात्रा	
5.	उत्पादों और उत्पादित अपशिष्ट निबंधनों में जिसके अधीन केप्टिव विद्युत उत्पादन और जल भी है, निवेश और उत्पादन को दर्शित करते हुए विनिर्माणकारी प्रक्रिया का एक प्रवाहित डायग्राम प्रस्तुत करें।	
6.	इन नियमों के अनुपालन की प्रास्थिति - मोटाई - पचास माइक्रोन (हां/नहीं)	
	भाग-ख द्रव बहिस्राव और गैसीय उत्सर्जन से संबंधित	
7.	(क) क्या इकाई, जल (प्रदूषण निवारण और नियंत्रण) अधिनियम, 1974 (1974 का 6) के अधीन विधिमान्य सहमति रखती है? यदि हां, तो प्रति संलग्न करें।	
	(ख) क्या इकाई, वायु (प्रदूषण निवारण और नियंत्रण) अधिनियम, 1981 (1981 का 14) के अधीन विधिमान्य सहमति रखती है? यदि हां, तो प्रति संलग्न करें।	
	भाग-ग	

अपशिष्ट से संबंधित		
8.	ठोस अपशिष्ट : (क) उत्पादित अपशिष्ट की कुल मात्रा (ख) संयंत्र के भीतर भंडारण की पद्धति (ग) अपशिष्टों के व्ययन के लिए किए गए अपबंध	
9.	कैरी बैग अथवा समान प्रकार की प्लास्टिक शीट अथवा बहुस्तरीय पैकेजिंग के विनिर्माण के लिए कच्ची सामग्री के रूप में प्रयुक्त किए जाने के लिए प्लास्टिक की आपूर्ति करने वाले व्यक्तियों की सूची संलग्न करें/उपलब्ध कराएं।	
10.	उन कार्मिकों या ब्रांड स्वामियों की सूची संलग्न करें/उपलब्ध कराएं जिन्हें उत्पादों की आपूर्ति की जाएगी	
11.	प्लास्टिक अपशिष्ट का वापस संग्रहण करने की कार्य योजना	
		नाम और हस्ताक्षर पदनाम
तारीख : स्थान :		

II ब्रांड स्वामी

भाग-क सामान्य		
1.	नाम, पता और संपर्क नम्बर	
2.	नवीकरण की दशा में पिछला रजिस्ट्रीकरण नम्बर और रजिस्ट्रीकरण की तारीख	
3.	क्या इकाई राज्य सरकार या संघ राज्य क्षेत्र के जिला उद्योग केन्द्र या डीसीएसएसआई में रजिस्ट्रीकृत है? यदि हां, तो प्रति संलग्न करें।	
4.(क)	परियोजना में निवेशित कुल पूंजी	
(ख)	उत्पादन प्रारंभ करने का वर्ष	
5.(क)	उत्पादों और उप उत्पादों की सूची और मात्रा	
(ख)	प्रयुक्त कच्ची सामग्री की सूची और मात्रा	
भाग - ख द्रव बहिस्राव और गैसीय उत्सर्जन से संबंधित		
5.	(क) क्या इकाई, जल (प्रदूषण निवारण और नियंत्रण) अधिनियम, 1974 (1974 का 6) के अधीन विधिमान्य सहमति रखती है? यदि हां, तो प्रति संलग्न करें।	
6.	(ख) क्या इकाई, वायु (प्रदूषण निवारण और नियंत्रण) अधिनियम, 1981 (1981 का 14) के अधीन विधिमान्य सहमति रखती है? यदि हां, तो प्रति संलग्न करें।	

भाग-ग अपशिष्ट से संबंधित		
7.	ठोस अपशिष्ट : (क) उत्पादित अपशिष्ट की कुल मात्रा (ख) संयंत्र के भीतर भंडारण की पद्धति (ग) अपशिष्टों के व्ययन के लिए किए गए अपबंध	

8.	उन कार्मिकों या ब्रांड स्वामियों की सूची संलग्न करें/उपलब्ध कराएं जिन्हें उत्पादों की आपूर्ति की जाएगी	
9.	प्लास्टिक अपशिष्ट का वापस संग्रहण करने की कार्य योजना	
	नाम और हस्ताक्षर पदनाम तारीख : स्थान :	

प्रपत्र - II

[नियम 13 (3) देखें)]

प्लास्टिक अपशिष्ट के प्रसंस्करण एवं पुनर्चक्रण में संलग्न इकाइयों के पंजीकरण हेतु आवेदन-प्रपत्र

1.	इकाई का नाम और पता				
2.	संपर्क व्यक्ति, पदनाम, टेलीफोन/फैक्स/ई-मेल सहित				
3.	प्रारंभ किए जाने की तारीख				
4.	कर्मकारों की संख्या (संविदा श्रम सहित)				
5.	सहमति विधिमान्यता	क. जल (प्रदूषण निवारण तथा नियंत्रण) अधिनियम, 1974 ..... तक विधिमान्य ख. वायु (प्रदूषण निवारण तथा नियंत्रण) अधिनियम, 1981 ..... तक विधिमान्य ग. प्राधिकरण ; ..... तक विधिमान्य			
6.	विनिर्माण प्रक्रिया	कृपया विनिर्माण, प्रक्रिया का प्रवाहित डायग्राम संलगन करें प्रत्येक उत्पाद के लिए प्रवाहित डायग्राम।			
7.	उत्पाद और उत्पादन की संस्थित क्षमता (एमटीए)	उत्पाद		संस्थित क्षमता	
8.	अपशिष्ट प्रबंधन	क्रम सं.	किस्म	श्रेणी	मात्रा
	क. प्लास्टिक अपशिष्ट में अपशिष्ट जनन	(i)			
		(ii)			
		(iii)			
	ख. अपशिष्ट संग्रह और परिवहन (विवरण संलगन करें)				
	ग. अपशिष्ट निपटान का विवरण	क्रम सं.	किस्म	श्रेणी	मात्रा
		(i)			
		(ii)			
	घ. निपटान सुविधा का ब्यौरा उपलब्ध कराएं, क्या सुविधा एसपीसीबी या पीसीसी द्वारा प्राधिकृत है				
	ड. कृपया जनित अपशिष्ट के वर्गीकरण की विश्लेषण रिपोर्ट संलग्न करें (यदि लागू हो तो लीचेट परीक्षण सहित)				
9.	कच्ची सामग्री के रूप में उपयोग के लिए, यथा स्थिति, बिक्री, नीलामी, संविदा या आयात के जरिए अर्जित होने वाले प्रस्तावित प्लास्टिक अपशिष्ट का ब्यौरा	(i) नाम (ii) प्रति वर्ष अपेक्षित मात्रा			
10.	व्यावसायिक सुरक्षा और स्वास्थ्य संबंधी पहलू	कृपया सुविधाओं का ब्यौरा दें			
11.	प्रदूषण नियंत्रण के उपाय				
	क्या उत्सर्जन या बहि:स्राव के मानकों को पूरा करने के				

	लिए इकाई के पास पर्याप्त प्रदूषण नियंत्रण प्रणालियां या उपस्कर है।	
	क्या इकाई उक्त नियमों में निर्धारित शर्तों का अनुपालन करती है।	
	क्या हथालन अथवा प्रसंस्कृत की जारी सामग्री के पर्यावरण पर पड़ने वाले तत्काल या विलंब से पड़ने वाले प्रतिकूल प्रभाव के लिए परिस्थितियां विद्यमान हैं या विद्यमान होने की संभावना है।	
	क्या हथालन अथवा प्रसंस्कृत की जा रही सामग्री किसी भी साधन से अन्य सामग्री (अर्थात् लीचेट) उत्पन्न करने में सक्षम है, उसके लिए परिस्थितियां विद्यमान हैं (या विद्यमान होने की संभावना है जिसमें विषाक्तता हो सकती है)	
12.	कोई अन्य प्रासंगिक सूचना, जिसमें अग्नि या दुर्घटना प्रशमनकारी उपाय शामिल है	
13.	नियमानुसार संलग्नों की सूची	

नाम और हस्ताक्षर

पदनाम

तारीख :

स्थान :

प्ररूप-III

[नियम 13(4) देखें]

अपरिष्कृत प्लास्टिक विनिर्माताओं के लिए पंजीकरण हेतु आवेदन पत्र

प्रेषक .....

.....

..... (अधिष्ठाता का नाम और पूरा पता)

सेवा में,

सदस्य सचिव,

..... प्रदूषण नियंत्रण बोर्ड/प्रदूषण नियंत्रण समिति

.....

.....

महोदय,

मैं/हम प्लास्टिक अपशिष्ट प्रबंधन नियम, 2011 के अंतर्गत पंजीकरण हेतु आवेदन करता हूं/करते हैं।

भाग-क सामान्य		
1. (क)	इकाई का नाम और अवस्थिति	
(ख)	इकाई का पता	
(ग)	नवीकरण के मामले में, पिछली रजिस्ट्रीकरण संख्या और रजिस्ट्रीकरण की तारीख	
2.	क्या यह इकाई राज्य सरकार/संघ राज्य क्षेत्र की डीआईसी/डीसीएसएसआई में रजिस्ट्रीकृत है? यदि हो, तो	

	रजिस्ट्रीकरण की प्रति संलग्न करें।	
3. (क)	परियोजना पर निवेश की गई कुल पूंजी	
(ख)	उत्पादन शुरू करने का वर्ष	
(ग)	उत्पादकों की सूची और उत्पादकों को आपूर्ति किए गए कच्चे माल की प्रमात्रा	
		नाम और हस्ताक्षर पदनाम
तारीख : स्थान :		

प्ररूप-IV

(नियम 17(1) देखें)

स्थानीय निकाय को प्लास्टिक प्रसंस्करण या पुन:चक्रण सुविधा के प्रचालनकर्ता द्वारा प्रस्तुत की जाने वाली वार्षिक रिपोर्ट का प्रपत्र

रिपोर्टिंग की अवधि :

(1)	सुविधा के प्रचालकर्ता का नाम और पता	
(2)	सुविधा के प्रभारी अधिकारी का नाम (दूरभाष/फैक्स/मोबाइल/ई-मेल)	
(3)	क्षमता :	
(4)	प्लास्टिक अपिशष्ट के प्रबंधन हेतु प्रयुक्त प्रौद्योगिकियां :	
(5)	प्रस्तुत रिपोर्ट के वर्ष के दौरान प्राप्त प्लास्टिक अपशिष्ट की प्रमात्रा तथा उसका स्रोत	
(6)	प्रसंस्कृत प्लास्टिक अपशिष्ट की प्रमात्रा (टनों में) : - पुनर्चक्रित पलास्टिक अपशिष्ट (टन में) - प्रसंस्कृत प्लास्टिक अपशिष्ट (टन में) - उपयोग में लाया गया (टन में)	
(7)	खत्ता स्थलों में अंतिम निपटान हेतु भेजे गए बेकार/अस्वीकृत अपशिष्टों की प्रमात्रा :	
(8)	उस खत्ता सुविधा का ब्यौरा जहां बेकार/अस्वीकृत अपशिष्टों को अंतिम निपटान हेतु भेजा गया है : - पता - दूरभाष	
(9)	सहमति प्रदान करने या पंजीकरण के दौरान यदि कोई पर्यावरणीय शर्त विनिर्दिष्ट की गई हो तो उसके अनुपालन की स्थिति संलग्न करें।	

प्रचालनकर्ता के हस्ताक्षर

तारीख :

स्थान :

प्ररूप-V

(नियम 17(2) देखें)

स्थानीय निकाय द्वारा प्रस्तुत की जाने वाली प्लास्टिक अपशिष्ट प्रबंधन संबंधी वार्षिक रिपोर्ट का प्रपत्र

रिपोर्ट प्रस्तुत करने की अवधि :

(1)	शहर/नगर और राज्य का नाम	
(2)	जनसंख्या	
(3)	वर्ग किलोमीटर में क्षेत्र	
(4)	स्थानीय निकाय का नाम और पता टेलीफोन सं. फैक्स सं. ई-मेल :	
(5)	क्षेत्राधिकार के अंतर्गत क्षेत्र में वार्डों की कुल संख्या	
(6)	क्षेत्राधिकार के अंतर्गत क्षेत्र में घरों की कुल संख्या	
(7)	घर-घर जाकर किए गए एकत्र करने में शामिल घरों की संख्या	
(8)	क्षेत्राधिकार के अंतर्गत क्षेत्र में वाणिज्यिक संस्थाओं और संस्थानों की कुल संख्या - वाणिज्यिक संस्थाएं - संस्थान	
(9)	प्रत्येक संस्थान/संस्थान में जाकर एकत्र करने के लिए सम्मिलित वाणिज्यिक संस्थाओं और संस्थानों की संख्या - वाणिज्यिक संस्थाएं - संस्थान	
(10)	घर-घर जाकर एकत्रण में शामिल एजेंसियों के ब्यौरे सहित क्षेत्राधिकार के अंतर्गत क्षेत्र में प्लास्टिक अपशिष्ट के प्रबंधन हेतु तैयार किए गए तंत्रों का सारांश	
(11)	क्षेत्राधिकार के अंतर्गत क्षेत्र में उत्पन्न प्लास्टिक अपशिष्ट के प्रबंधन हेतु तैयार की गई अवसंरचना का ब्यौरा संलग्न करें	
(12)	अपेक्षित अवसंरचना, यदि कोई हो, के औचित्य सहित उसका ब्यौरा संलग्न करें	
(13)	क्षेत्राधिकार के अंतर्गत वर्ष के दौरान उत्पन्न प्लास्टिक अपशिष्ट की मात्रा (टन में)	
(14)	क्षेत्राधिकार के अंतर्गत क्षेत्र से वर्ष के दौरान एकत्रित किए गए प्लास्टिक अपशिष्ट की मात्रा (टन में)	
(15)	वर्ष के दौरान पुनर्चक्रण हेतु भेजे गए प्लास्टिक अपशिष्ट की मात्रा (टन में)	
(16)	वर्ष के दौरान उपयोग हेतु भेजे गए प्लास्टिक अपशिष्ट की मात्रा (टन में)	
(17)	वर्ष के दौरान भू-भराव स्थलों को भेजे गए बेकार/अस्वीकृत प्लास्टिक अपशिष्ट की मात्रा (टन में)	
(18)	प्लास्टिक अपशिष्ट के प्रसंस्करण और निपटान हेतु प्रयुक्त प्रत्येक सुविधा का ब्यौरा **सुविधा-1** i) प्रचालक का नाम ii) टेलीफोन नंबर/मोबाइल नंबर सहित पता iii) क्षमता iv) प्रयुक्त प्रौद्योगिकी v) पंजीकरण संख्या	

	vi) पंजीकरण की वैधता (तक) **सुविधा-2** i) प्रचालक का नाम ii) टेलीफोन नंबर/मोबाइल नंबर सहित पता iii) क्षमता iv) प्रयुक्त प्रौद्योगिकी v) पंजीकरण संख्या vi) पंजीकरण की वैधता (तक)	
(19)	ब्यौरा दें : गली की सफाई, अपशिष्ट के द्वितीयक भंडारण, परिवहन, प्रसंस्करण और निपटान सहित एकत्रण हेतु तैनात की गई स्थानीय निकायों की निजी जनशक्ति।	
(20)	ब्यौरा दें : गली की सफाई, अपशिष्ट के द्वितीयक भंडारण, परिवहन, प्रसंस्करण और निपटान सहित एकत्रण हेतु तैनात की गई ठेकेदार/ग्रहियों की जनशक्ति।	
(21)	वित्तीय बाध्यताओं, सहित इन नियमों के उपबंधों के अनुपालन में शहरी स्थानीय निकाय द्वारा अनुभव की जा रही कठिनाइयों, यदि कोई हों, का उल्लेख करें	
(22)	क्या शहर में ठोस अपशिष्ट प्रबंधन पद्धतियों में सुधार करने के लिए कार्य योजना तैयार की गई है? यदि हो तो (प्रति संलग्न करें) संशोधन की तारीख :	

मुख्य कार्यकारी अधिकारी/नगर आयुक्त/कार्यकारी अधिकारी/

मुख्य अधिकारी के हस्ताक्षर

तारीख :

स्थान :

प्ररूप-VI

प्लास्टिक अपशिष्ट प्रबंधन नियम, 2016 के कार्यान्वयन की वर्ष ..... की राज्यवार स्थिति

राज्य प्रदूषण नियंत्रण बोर्ड अथवा प्रदूषण नियंत्रण समिति का नाम	अनुमानित प्लास्टिक अपशिष्ट जनन टन प्रति वर्ष (टीपीए)	रजिस्ट्रीकृत प्लास्टिक विनिर्माता या पुन: चक्रण इकाइयों की संख्या (प्रवर्धक, कंपोस्ट योज्य सहित) (नियम 9)			गैर-रजिस्ट्रीकृत प्लास्टिक विनिर्माता या पुन:चक्रण इकाईयों की संख्या (आवासीय या अनधिकृत क्षेत्रों में)	प्लास्टिक अपशिष्ट प्रबंधन का विवरण (पीडब्ल्यूएम) अर्थात संग्रहण, पृथक्करण, निपटान (सह-प्रसंस्करण सड़क निर्माण आदि) (नियम 6) (अलग पृष्ठ संलग्न करें)	प्लास्टिक कैरी बैग के उपयोग पर आंशिक अथवा पूर्ण प्रतिबंध (कार्यकारी आदेश के जरिए) (अधिसूचना या कार्यकारी आदेश की प्रति संलग्न करें)	कैरी बैग पर मार्क करने, लेबल लगाने की स्थिति (नियम 8) (अनुपालन करने/अनुपालन नहीं करने वाली इकाइयों की संख्या का उल्लेख करें)	कैरी बैगों का स्पष्ट मूल्य निर्धारण करना (नियम 10)	राज्य स्तरीय सलाहकार संस्था (एसएलए) की बैठकों तथा साथ ही कार्यान्वयन के संबंध में इसकी सिफारिशों का विवरण (नियम 11)	उल्लंघनों की संख्या और इन नियमों के प्रावधानों का पालन नहीं करने पर की गई कारवाई	क्षेत्राधिकार के अधीन म्युनिसिपल प्राधिकरणों या ग्राम पंचायतों की संख्या और केन्द्रीय प्रदूषण नियंत्रण बोर्ड को वार्षिक रिपोर्ट प्रस्तुत करना (नियम 12)
		प्लास्टिक इकाई	कंपोस्ट योज्य प्लास्टिक इकाई	बहुस्तरीय प्लास्टिक इकाई							
(1)	(2)	(3)			(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)

[फा. सं. 17—2/2001—एचएसएमडी]

विश्वनाथ सिन्हा, संयुक्त सचिव

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 18th March, 2016

G.S.R. 320(E).—Whereas the Plastic Waste (Management and Handling) Rules, 2011 published vide notification number S.O 249(E), dated 4th February, 2011 by the Government of India in the erstwhile Ministry of Environment and Forests, as amended from time to time, provided a regulatory frame work for management of plastic waste generated in the country;

And whereas, to implement these rules more effectively and to give thrust on plastic waste minimization, source segregation, recycling, involving waste pickers, recyclers and waste processors in collection of plastic waste fraction either from households or any other source of its generation or intermediate material recovery facility and adopt polluter's pay principle for the sustainability of the waste management system, the Central Government reviewed the existing rules;

And whereas, in exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the draft rules, namely, the Plastic Waste Management, Rules, 2015 were published by the Government of India in the Ministry of Environment, Forest and Climate Change *vide* number G.S.R. 423(E), dated the 25th May, 2015 in the Gazette of India, inviting objections and suggestions from all persons likely to be affected thereby, before the expiry of a period of sixty days from the date on which copies of the Gazette containing the said notification were made available to the public;

And Whereas copies of the said Gazette were made available to the public on the 25th May, 2015;

And Whereas the objections and suggestions received within the said period from the public in respect of the said draft rules have been duly considered by the Central Government**;**

NOW, Therefore, in exercise of the powers conferred by sections 3, 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), and in supersession of the Plastic Waste (Management and Handling) Rules, 2011, except as respects things done or omitted to be done before such supersession, the Central Government hereby makes the following rules, namely:-

1. Short title and commencement.- (1) These rules shall be called the Plastic Waste Management Rules, 2016.

(1) Save as otherwise provided in these rules, they shall come into force on the date of their publication in the Official Gazette.

2. Application.-(1) These rules shall apply to every waste generator, local body, Gram Panchayat, manufacturer, Importers and producer.

(2) The rule 4 shall not apply to the export oriented units or units in special economic zones, notified by the Central Government, manufacturing their products against an order for export: Provide this exemption shall not apply to units engaged in packaging of gutkha, tobacco and pan masala and also to any surplus or rejects, left over products and the like.

3. Definitions.- In these rules, unless the context otherwise requires.-

(a) **"Act"** means the Environment (Protection) Act, 1986 (29 of 1986);

(b) **"brand owner"** means a person or company who sells any commodity under a registered brand

label.

(c) **"carry bags"** mean bags made from plastic material or compostable plastic material, used for the purpose of carrying or dispensing commodities which have a self carrying feature but do not include bags that constitute or form an integral part of the packaging in which goods are sealed prior to use.

(d) **"commodity"** means tangible item that may be bought or sold and includes all marketable goods or wares;

(e) "**compostable plastics**" mean plastic that undergoes degradation by biological processes during composting to yield CO_2, water, inorganic compounds and biomass at a rate consistent with other known compostable materials, excluding conventional petro-based plastics, and does not leave visible, distinguishable or toxic residue;

(f) **"consent"** means the consent to establish and operate from the concerned State Pollution Control Board or Pollution Control Committee granted under the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974), and the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981);

(g) "**disintegration**" means the physical breakdown of a material into very small fragments;

(h) **"extended producer's responsibility "** means the responsibility of a producer for the environmentally sound management of the product until the end of its life;

(i) **"food-stuffs"** mean ready to eat food products, fast food, processed or cooked food in liquid, powder, solid or semi-solid form;

(j) **"facility"** means the premises used for collection, Storage, recycling, processing and disposal of plastic waste;

(k) **"importer"** means a person who imports or intends to import and holds an Importer -Exporter Code number, unless otherwise specifically exempted.

(l) **"institutional waste generator"** means and includes occupier of the institutional buildings such as building occupied by Central Government Departments, State Government Departments, public or private sector companies, hospitals, schools, colleges, universities or other places of education, organisation, academy, hotels, restaurants, malls and shopping complexes;

(m) "**manufacturer"** means and include a person or unit or agency engaged in production of plastic raw material to be used as raw material by the producer.

(n) **"multilayered packaging"** means any material used or to be used for packaging and having at least one layer of plastic as the main ingredients in combination with one or more layers of materials such aspaper, paper board, polymeric materials, metalised layers or aluminium foil, either in the form of a laminate or co-extruded structure;

(o) **"plastic"** means material which contains as an essential ingredient a high polymer such as polyethylene terephthalate, high density polyethylene, Vinyl, low density polyethylene, polypropylene, polystyrene resins, multi-materials like acrylonitrile butadiene styrene, polyphenylene oxide, polycarbonate, Polybutylene terephthalate;

(p) **"plastic sheet"** means Plastic sheet is the sheet made of plastic;

(q) **"plastic waste"**means any plastic discardedafter use or after their intended use is over;

(r) **"prescribed authority"** means the authorities specified in rule 12;

(s) **"producer"** means persons engaged in manufacture or import of carry bags or multilayered packaging or plastic sheets or like, and includes industries or individuals using plastic sheets or like or covers made of plastic sheets or multilayered packaging for packaging or wrapping the commodity;

(t) **"recycling"** means the process of transforming segregated plastic waste into a new product or raw material for producing new products;

(u) **"registration"** means registration with the State Pollution Control Board or Pollution Control Committee concerned, as the case may be;

(v) **"street vendor"** shall have the same meaning as assigned to it in clause (l) of sub-section (1) of Section 2 of the Street Vendors (Protection of Livelihood and Regulation of Street Vending) Act, 2014 (7 of 2014);

(w) **"local body"** means urban local body with different nomenclature such as municipal corporation, municipality, nagarpalika, nagarnigam, nagarpanchayat, municipal council including notified area committee (NAC) and not limited to or any other local body constituted under the relevant statutes such as gram panchayat, where the management of plastic waste is entrusted to such agency;

(x) **"virgin plastic"** means plastic material which has not been subjected to use earlier and has also not been blended with scrap or waste;

(y) **"waste generator"** means and includes every person or group of persons or institution, residential and commercial establishments including Indian Railways, Airport, Port and Harbour and Defense establishments which generate plastic waste;

(z) **"waste management"** means the collection, storage, transportation reduction, re-use, recovery, recycling, composting or disposal of plastic waste in an environmentally safe manner;

(aa) **"waste pickers"** mean individuals or agencies, groups of individuals voluntarily engaged or authorised for picking of recyclable plastic waste.

4. Conditions.- (1) The manufacture, importer stocking, distribution, sale and use of carry bags, plastic sheets or like, or cover made of plastic sheet and multilayered packaging, shall be subject to the following conditions, namely:-

a) carry bags and plastic packaging shall either be in natural shade which is without any added pigments or made using only those pigments and colourants which are in conformity with Indian Standard : IS 9833:1981 titled as "List of pigments and colourants for use in plastics in contact with foodstuffs, pharmaceuticals and drinking water", as amended from time to time;

b) Carry bags made of recycled plastic or products made of recycled plastic shall not be used for storing, carrying, dispensing or packaging ready to eat or drink food stuff';

c) carry bag made of virgin or recycled plastic, shall not be less than fifty microns in thickness;

d) plastic sheet or like, which is not an integral part of multilayered packaging and cover made of plastic sheet used for packaging, wrapping the commodity shall not be less than fifty microns in thickness except where the thickness of such plastic sheets impair the functionality of the product;

e) the manufacturer shall not sell or provide or arrange plastic to be used as raw material to a producer, not having valid registration from the concerned State Pollution Control Boards or Pollution Control Committee;

f) sachets using plastic material shall not be used for storing, packing or selling gutkha, tobacco and pan masala;

g) recycling of plastic waste shall conform to the Indian Standard: IS 14534:1998 titled as Guidelines for Recycling of Plastics, as amended from time to time;

h) The provision of thickness shall not be applicable to carry bags made up of compostable plastic. Carry bags made from compostable plastics shall conform to the Indian Standard: IS 17088:2008 titled as Specifications for Compostable Plastics, as amended from time to time. The manufacturers or seller of compostable plastic carry bags shall obtain a certificate from the Central Pollution Control Board before marketing or selling; and

i) plastic material, in any form including Vinyl Acetate - Maleic Acid - Vinyl Chloride Copolymer, shall not be used in any package for packaging gutkha, pan masala and tobacco in all forms.

5. Plastic waste management.- (1) The plastic waste management by the urban local bodies in their respective jurisdiction shall be as under:-

(a) plastic waste, which can be recycled, shall be channelized to registered plastic waste recycler and recycling of plastic shall conform to the Indian Standard: IS 14534:1998 titled as Guidelines for Recycling of Plastics, as amended from time to time.

(b) local bodies shall encourage the use of plastic waste (preferably the plastic waste which cannot be further recycled) for road construction as per Indian Road Congress guidelines or energy recovery or waste to oil etc. The standards and pollution control norms specified by the prescribed authority for these technologies shall be complied with.

(c) Thermo set plastic waste shall be processed and disposed off as per the guidelines issued from time to time by the Central Pollution Control Board.

(d) The inert from recycling or processing facilities of plastic waste shall be disposed of in compliance with the Solid Waste Management Rules, 2000 or as amended from time to time.

6. Responsibility of local body.- (1) Every local body shall be responsible for development and setting up of infrastructure for segregation, collection, storage, transportation, processing and disposal of the plastic waste either on its own or by engaging agencies or producers.

(2) The local body shall be responsible for setting up, operationalisation and co-ordination of the waste management system and for performing the associated functions, namely:-

(a) Ensuring segregation, collection, storage, transportation, processing and disposal of plastic waste;

(b) ensuring that no damage is caused to the environment during this process;

(c) ensuring channelization of recyclable plastic waste fraction to recyclers;

(d) ensuring processing and disposal on non-recyclable fraction of plastic waste in accordance with the guidelines issued by the Central Pollution Control Board;

(e) creating awareness among all stakeholders about their responsibilities;

(f) engaging civil societies or groups working with waste pickers; and

(g) ensuring that open burning of plastic waste does not take place.

(3) The local body for setting up of system for plastic waste management shall seek assistance of producers and such system shall be set up within one year from the date of final publication of these rules in the Official Gazaette of India.

(4) The local body to frame bye-laws incorporating the provisions of these rules.

7. Responsibility of Gram Panchayat.- (1) Every gram panchayat either on its own or by engaging an agency shall set up, operationalise and co-ordinate for waste management in the rural area under their control and for performing the associated functions, namely,-

(a) ensuring segregation, collection, storage, transportation, plastic waste and channelization of recyclable plastic waste fraction to recyclers having valid registration; ensuring that no damage is caused to the environment during this process;

(b) creating awareness among all stakeholders about their responsibilities; and

(c) ensuring that open burning of plastic waste does not take place

8. Responsibility of waste generator.- (1) The waste generator shall.-

(a) take steps to minimize generation of plastic waste and segregate plastic waste at source in accordance with the Solid Waste Management Rules, 2000 or as amended from time to time.

(b) not litter the plastic waste and ensure segregated storage of waste at source and handover segregated waste to urban local body or gram panchayat or agencies appointed by them or registered waste pickers', registered recyclers or waste collection agencies;

(2) All institutional generators of plastic waste, shall segregate and store the waste generated by them in accordance with the Municipal Solid Waste (Management and Handling) Rules, 2000 notified vide S.O. 908(E) dated the 25th September, 2000 under the Act or amendment from time to time and handover

segregated wastes to authorized waste processing or disposal facilities or deposition centers either on its own or through the authorized waste collection agency.

(3) All waste generators shall pay such user fee or charge as may be specified in the bye-laws of the local bodies for plastic waste management such as waste collection or operation of the facility thereof, etc.;

(4) Every person responsible for organising an event in open space, which involves service of food stuff in plastic or multilayered packaging shall segregate and manage the waste generated during such events in accordance with the Municipal Solid Waste (Management and Handling) Rules, 2000 notified vide
S.O. 908(E) dated the 25th September, 2000 under the Act or amendment from time to time.

9. Responsibility of producers, **Importers and Brand Owners.-** (1) The producers, within a period of six months from the date of publication of these rules, shall work out modalities for waste collection system based on Extended Producers Responsibility and involving State Urban Development Departments, either individually or collectively, through their own distribution channel or through the local body concerned.

(2) Primary responsibility for collection of used multi-layered plastic sachet or pouches or packaging is of Producers, Importers and Brand Owners who introduce the products in the market. They need to establish a system for collecting back the plastic waste generated due to their products. This plan of collection to be submitted to the State Pollution Control Boards while applying for Consent to Establish or Operate or Renewal. The Brand Owners whose consent has been renewed before the notification of these rules shall submit such plan within one year from the date of notification of these rules and implement with two years thereafter.

(3) manufacture and use of non- recyclable multilayered plastic if any should be phased out in Two years time.

(4) The producer, within a period of three months from the date of final publication of these rules in the Official Gazette shall apply to the Pollution Control Board or the Pollution Control Committee, as the case may be, of the States or the Union Territories administration concerned, for grant of registration.

(5) No producer shall on and after the expiry of a period of Six Months from the date of final publication of these rules in the Official Gazette manufacture or use any plastic or multilayered packaging for packaging of commodities without registration from the concerned State Pollution Control Board or the Pollution Control Committees.

(6) Every producer shall maintain a record of details of the person engaged in supply of plastic used as raw material to manufacture carry bags or plastic sheet or like or cover made of plastic sheet or multilayered packaging.

10. Protocols for compostable plastic materials.-Determination of the degree of degradability and degree of disintegration of plastic material shall be as per the protocols of the Indian Standards listed in Schedule-I to these rules.

11. Marking or labelling.-(1) Each plastic carry bag and multilayered packaging shall have the following information printed in English namely,-

(a) name, registration number of the manufacturer and thickness in case of carry bag;

(b) name and registration number of the manufacturer in case of multilayered packaging; and

(c) name and certificate number [Rule 4(h)] in case of carry bags made from compostable plastic

(2) Each recycled carry bag shall bear a label or a mark “recycled” as shown below and shall conform to the Indian Standard: IS 14534: 1998 titled as “Guidelines for Recycling of Plastics”, as amended from time to time;

NOTE: PET-Polyethylene terephthalate, HDPE-High density polyethylene, V-Vinyl (PVC), LDPE- Low density polyethylene, PP-Polypropylene, PS-Polystyrene and Other means all other resins and multi-materials like ABS (Acrylonitrile butadiene styrene), PPO (Polyphenylene oxide), PC (Polycarbonate), PBT (Polybutylene terephalate) etc.

Each carry bag made from compostable plastics shall bear a label "compostable" and shall conform to the Indian Standard : IS or ISO 17088:2008 titled as Specifications for "Compostable Plastics".

12. Prescribed authority.- (1) The State Pollution Control Board and Pollution Control Committee in respect of a Union territory shall be the authority for enforcement of the provisions of these rules relating to registration, manufacture of plastic products and multilayered packaging, processing and disposal of plastic wastes.

(2) The concerned Secretary-in-charge of Urban Development of the State or a Union Territory shall be the authority for enforcement of the provisions of these rules relating to waste management by waste generator, use of plastic carry bags, plastic sheets or like, covers made of plastic sheets and multilayered packaging.

(3) The concerned Gram Panchayat shall be the authority for enforcement of the provisions of these rules relating to waste management by the waste generator, use of plastic carry bags, plastic sheets or like, covers made of plastic sheets and multilayered packaging in the rural area of the State or a Union Territory.

(4) The authorities referred to in sub-rules (1) to (3) shall take the assistance of the District Magistrate or the Deputy Commissioner within the territorial limits of the jurisdiction of the concerned district in the enforcement of the provisions of these rules.

13. Registration of producer, recyclers and manufacturer,- (1) No person shall manufacture carry bags or recycle plastic bags or multilayered packaging unless the person has obtained a registration from the State Pollution Control Board or the Pollution Control Committee of the Union Territory concerned, as the case may be, prior to the commencement of production;

(2) Every producer shall, for the purpose of registration or for renewal of registration, make an application to the State Pollution Control Board or the Pollution Control Committee of the Union territory concerned, in Form I

(3) Every person recycling or processing waste or proposing to recycle or process plastic waste shall make an application to the State Pollution Control Board or the Pollution Control Committee, for grant of registration or renewal of registration for the recycling unit, in Form II.

(4) Every manufacturer engaged in manufacturer of plastic to be used as raw material by the producer shall make an application to the State Pollution Control Board or the Pollution Control Committee of the Union territory concerned, for the grant of registration or for the renewal of registration, in Form III.

(5) The State Pollution Control Board or the Pollution Control Committee shall not issue or renew registration to plastic waste recycling or processing units unless the unit possesses a valid consent under the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974) and the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981) along with a certificate of registration issued by the District Industries Centre or any other Government agency authorised in this regard.

(6) The State Pollution Control Board or the Pollution Control Committee shall not renew registration of producer unless the producer possesses and action plan endorsed by the Secretary in charge of Urban Development of the concerned State or Union Territory for setting of plastic waste management system.

(7) On receipt of the application complete in all respects for the registration for recycling or processing of plastic waste under sub-rule (3), the State Pollution Control Board may, after such inquiry as it considers necessary and on being satisfied that the applicant possesses appropriate facilities, technical capabilities and equipment to handle plastic waste safely, may grant registration to the applicant on fulfilment of the conditions as may be laid down in terms of registration.

(8) Every State Pollution Control Board or Pollution Control Committee shall take a decision on the grant of registration within ninety days of receipt of an application which is complete in all respects.

(9) The registration granted under this rule shall initially be valid for a period of one year, unless revoked, suspended or cancelled and shall subsequently be granted for three years.

(10) State Pollution Control Board or the Pollution Control Committees shall not revoke, suspend or cancel registration without providing the opportunity of a hearing to the producer or person engaged in recycling or processing of plastic wastes.

(11) Every application for renewal of registration shall be made at least one hundred twenty days before the expiry of the validity of the registration certificate.

14. Responsibility of retailers and street vendors- (1) Retailers or street vendors shall not sell or provide commodities to consumer in carry bags or plastic sheet or multilayered packaging, which are not manufactured and labelled or marked, as per prescribed under these rules.

(2) Every retailers or street vendors selling or providing commodities in, plastic carry bags or multilayered packaging or plastic sheets or like or covers made of plastic sheets which are not manufactured or labelled or marked in accordance with these rules shall be liable to pay such fines as specified under the bye-laws of the local bodies.

15. Explicit pricing of carry bags.- (1) The shopkeepers and street vendors willing to provide plastic carry bags for dispensing any commodity shall register with local body. The local body shall, within a period of six months from the date of final publication of these rules ion the Official Gazette of India notification of these rules, by notification or an order under their appropriate state statute or byelaws shall make provisions for such registration on payment of plastic waste management fee of minimum rupees forty eight thousand @ rupees four thousand per month. The concerned local body may prescribe higher plastic waste management fee, depending upon the sale capacity. The registered shop keepers shall display at prominent place that plastic carry bags are given on payment.

(2) Only the registered shopkeepers or street vendors shall be eligible to provide plastic carry bags for dispensing the commodities.

(3) The local body shall utilize the amount paid by the customers for the carry bags exclusively for the sustainability of the waste management system within their jurisdictions.

16. State Level Monitoring Committee.- (1) The State government or the union Territory shall, for the purpose of effective monitoring of implementation of these rules, constitute a State Level Advisory Committee consisting of the following persons, namely;-

(a)	the Secretary, Department of Urban Development	- Chairman
(b)	Director from State Department of Environment	- Member
(c)	Member Secretary from State Pollution Control Board or Pollution Control Committee	- Member
(d)	Municipal Commissioner	- Member
(e)	one expert from Local Body	- Member
(f)	one expert from Non-Governmental involved in Waste Management	- Member

(g)	Commissioner, Value Added Tax or his nominee,	- Member
(h)	Sales Tax Commissioner or Officer	- Member
(i)	representative of Plastic Association, Drug Manufacturers Association, Chemical Manufacturers Association	- Member
(j)	one expert from the field of Industry	- Member and
(k)	one expert from the field of academic institution	- Member
(l)	Director , Municipal Administration	- Convener

The State Level Advisory Body shall meet at least once in Six Month and may invite experts, if it considers necessary.

17. Annual reports.- (1) Every person engaged in recycling or processing of plastic waste shall prepare and submit an annual report in Form-IV to the local body concerned under intimation to the concerned State Pollution Control Board or Pollution Control Committee by the 30th April, of every year.

(2) Every local body shall prepare and submit an annual report in Form –V to the concerned Secretary-in-charge of the Urban Development Department under intimation to the concerned State Pollution Control Board or Pollution Control Committee by the 30th June, every year.

(3) Each State Pollution Control Board or Pollution Control Committee shall prepare and submit an annual report in Form VI to the CPCB on the implementation of these rules by the 31st July, of every year.

(4) The CPCB shall prepare a consolidated annual report on the use and management of plastic waste and forward it to the Central Government along with its recommendations before the 31st August of every year.

SCHEDULE-I

[See rule 10]

1.	IS / ISO 14851: 1999 Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium-Method by measuring the oxygen demand in a closed Respirometer
2.	IS / ISO 14852: 1999 Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium-Method by analysis of evolved carbon dioxide
3.	IS / ISO 14853: 2005 Plastics- Determination of the ultimate anaerobic biodegradation of plastic materials in an aqueous system-Method by measurement of biogas production
4.	IS /ISO 14855-1: 2005 Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions-Method by analysis of evolved carbon dioxide (Part-1 General method)
5.	IS / ISO 14855-2: 2007 Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions-Method by analysis of evolved carbon dioxide (Part-2: Gravimetric measurement of carbon dioxide evolved in a laboratory- scale test)
6.	IS / ISO 15985: 2004 Plastics- Determination of the ultimate anaerobic biodegradation and disintegration under high-solids anaerobic digestion conditions- Methods by analysis of released biogas
7.	IS /ISO 16929: 2002 Plastics- Determination of degree of disintegration of plastic materials under defined composting conditions in a pilot - scale test
8.	IS / ISO 17556: 2003 Plastics- Determination of ultimate aerobic biodegradability in soil by measuring the oxygen demand in a Respirometer or the amount of carbon dioxide evolved
9.	IS / ISO 20200:2004 Plastics- Determination of degree of disintegration of plastic materials under simulated composting conditions in a laboratory - scale test

FORM - I

[See rules 13 (2)]

APPLICATION FOR REGISTRATION FOR PRODUCERS or Brand Owners

From: .....

……

…….(Name and full address of the occupier)

To

The Member Secretary,

.....……. Pollution Control Board or Pollution Control Committee

…….

…….

Sir,

I /We hereby apply for registration under rule 9 of the Plastic Waste Management Rules, 2015

1. Producers

	PART – A GENERAL	
1.(a)	Name and location of the unit	
(b)	Address of the unit	
(c)	Registration required for manufacturing of: (i) Carry bags; (a) petro- based, (b) Compostable (ii) Multilayered plastics	
(d)	Manufacturing capacity	
(e)	In case of renewal, previous registration number and date of registration	
2.	Is the unit registered with the District Industries Centre of the State Government or Union Territory? If yes, attach a copy.	
3.(a)	Total capital invested on the project	
(b)	Year of commencement of production	
4. (a)	List and quantum of products and by-products	
(b)	List and quantum of raw materials used	
5.	Furnish a flow diagram of manufacturing process showing input and output in terms of products and waste generated including for captive power generation and water.	
6.	Status of compliance with these rules- Thickness – fifty micron (Yes/No)	
	PART – B PERTAINING TO LIQUID EFFLUENT AND GASEOUS EMISSIONS	
7.	(a) Does the unit have a valid consent under the Water (Prevention and control of Pollution) Act, 1974 (6 of 1974)? If yes, attach a copy	
	(b) Does the unit have a valid consent under the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981)? If yes, attach a copy	
	PART – C PERTAINING TO WASTE	
8.	Solid Wastes or rejects: (a) Total quantum of waste generated (b) Mode of storage within the plant (c) Provision made for disposal of wastes	
9.	Attach or Provide list of person supplying plastic to be used as raw material to manufacture carry bags or plastic sheet of like or multilayered packaging	

10.	Attach or provide list of personnel or Brand Owners to whom the products will be supplied	
11.	Action plan on collecting back the plastic wastes	

Name and Signature

Designation

Date :
Place :

II Brand Owners:

	PART – A GENERAL	
1.	Name, Address and Contact number	
2	In case of renewal, previous registration number and date of registration	
3	Is the unit registered with the District Industries Centre of the State Government or Union Territory? If yes, attach a copy.	
4.(a)	Total capital invested on the project	
(b)	Year of commencement of production	
5. (a)	List and quantum of products and by-products	
(b)	List and quantum of raw materials used	
	PART – B PERTAINING TO LIQUID EFFLUENT AND GASEOUS EMISSIONS	
5	Does the unit have a valid consent under the Water (Prevention and control of Pollution) Act, 1974 (6 of 1974)? If yes, attach a copy	
6	Does the unit have a valid consent under the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981)? If yes, attach a copy	
	PART – C PERTAINING TO WASTE	
7.	Solid Wastes or rejects: (c) Total quantum of waste generated (d) Mode of storage within the plant (d) Provision made for disposal of wastes	
8.	Attach or Provide list of person supplying plastic material	
9	Action plan on collecting back the plastic wastes	

Name and Signature
Designation

Date :

Place :

FORM - II

[see rule 13 (3)]

APPLICATION FORM FOR REGISTRATION OF UNITS ENGAGED IN PROCESSING OR RECYCLING OF PLASTIC WASTE

1.	Name and Address of the unit	
2.	Contact person with designation, Tel./Fax /email	

3.	Date of commencement				
4.	No. of workers (including contract labour)				
5.	Consents Validity	a. Water (Prevention & Control of Pollution) Act, 1974; Valid up to _____ b. Air (Prevention & Control of Pollution) Act, 1981; Valid up to_____ c. Authorization ; valid up to ….			
6.	Manufacturing Process	Please attach a flow diagram of the manufacturing process flow diagram for each product.			
7.	Products and installed capacity of production (MTA)	Products		Installed capacity	
8.	Waste Management:	S. No.	Type	Category	Qty.
	a. Waste generation in processing plastic-waste	(i)			
		(ii)			
		(iii)			
	b. Waste Collection and transportation (attach details)				
	c. Waste Disposal details	S. No.	Type	Category	Qty
		(i)			
		(ii)			
	d. Provide details of the disposal facility, whether the facility is authorized by SPCB or PCC				
	e. Please attach analysis report of characterization of waste generated (including leachate test if applicable)				
9.	Details of plastic waste proposed to be acquired through sale, auction, contract or import, as the case may be, for use as raw material	(i) Name (ii) Quantity required /year			
10.	Occupational safety and health aspects	Please provide details of facilities			
11.	Pollution Control Measures				
	Whether the unit has adequate pollution control systems or equipment to meet the standards of emission or effluent.	If Yes, please furnish details			
	Whether unit is in compliance with conditions laid down in the said rules.	Yes/No			
	Whether conditions exist or are likely to exist of the material being handled or processed posing adverse immediate or delayed impacts on the environment.	Yes/No			
	Whether conditions exist (or are likely to exist) of the material being handled or processed by any means capable of yielding another material (e.g. leachate) which may possess eco-toxicity.	Yes/No			
12.	Any other relevant information including fire or accident mitigative measures				
13.	List of enclosures as per rule				

Name and Signature

Designation

Date :

Place :

FORM - III

[See rules 13(4)]

APPLICATION FOR REGISTRATION FOR MANUFACTURERS OF PLASTIC RAW MATERIALS

From: .....

……

…….(Name and full address of the occupier)

To

The Member Secretary,

.....……. Pollution Control Board or Pollution Control Committee

…….

…….

Sir,

I/We hereby apply for registration under the Plastic Waste Management Rules, 2011

	PART – A GENERAL	
1.(a)	Name and location of the unit	
(b)	Address of the unit	
(c)	In case of renewal, previous registration number and date of registration	
2.	Is the unit registered with the DIC or DCSSI of the State Government or Union Territory? If yes, attach a copy.	
3.(a)	Total capital invested on the project	
(b)	Year of commencement of production	
(c)	List of producers and quantum of raw materials supplied to producers	
		Name and Signature Designation
Date : Place :		

Form - IV

[See rules 17 (1)]

FORMAT OF ANNUAL REPORT BY OPERATOR OF PLASTIC WASTE PROCESSING OR RECYCLING FACILITY TO THE LOCAL BODY

Period of Reporting:

(1)	Name and Address of operator of the facility	
(2)	Name of officer in-charge of the facility (Telephone/Fax/Mobile/ E-mail)	
(3)	Capacity:	
(4)	Technologies used for management of plastic waste:	
(5)	Quantity of plastic waste received during the year being reported upon along with the source	
(6)	Quantity of plastic waste processed (in tons): - Plastic waste recycled(in tons) - Plastic waste processed (in tons) - Used (in tons)	
(7)	Quantity of inert or rejects sent for final disposal to landfill sites:	
(8)	Details of land fill facility to which inert or rejects were sent	

	for final disposal: - Address -Telephone	
(9)	Attach status of compliance to environmental conditions, if any specified during grant of Consent or registration	

Signature of Operator

Dated :

Place:

Form - V

[See rules 17(2)]

FORMAT FOR ANNUAL REPORT ON PLASTIC WASTE MANAGEMENT TO BE SUBMITTED BY THE LOCAL BODY

Period of Reporting:

(1)	Name of the City or Town and State:	
(2)	Population	
(3)	Area in sq. kilometers	
(4)	Name & Address of Local body Telephone No. Fax No. E-mail:	
(5)	Total Numbers of the wards in the area under jurisdiction	
(6)	Total Numbers of Households in the area under jurisdiction	
(7)	Number of households covered by door to door collection	
(8)	Total number of commercial establishments and Institutions in the area under jurisdiction -Commercial establishments - Institutions	
(9)	Number of commercial establishments and Institutions covered by door to door collection -Commercial establishments - Institutions	
(10)	Summary of the mechanisms put in place for management of plastic waste in the area under jurisdiction along with the details of agencies involved in door to door collection	
(11)	Attach details of infrastructure put in place for management of plastic waste generated in the area under jurisdiction	
(12)	Attach details of infrastructure required, if any along with justification	
(13)	Quantity of Plastic Waste generated during the year from area under jurisdiction (in tons)	
(14)	Quantity of Plastic Waste collected during the year from area under jurisdiction (in tons)	
(15)	Quantity of plastic waste channelized for recycling during the year (in tons)	
(16)	Quantity of plastic waste channelized for use during the year (in tons)	
(17)	Quantity of inert or rejects sent to landfill sites during the year (in tons)	
(18)	Details of each of facilities used for processing and disposal of plastic waste **Facility-I** i) Name of operator ii) Address with Telephone Number or Mobile iii) Capacity iv) Technology Used v) Registration Number vi) Validity of Registration (up to)	

Name of the SPCB or PCC	Estimated Plastic Waste generation Tons Per Annum (TPA)	No. of registered Plastic Manufacturing or Recycling (including multilayer, compostable) units. (Rule 9)			No. of Unregistered plastic manufacturing Recycling units. (in residential or unapproved areas)	Details of Plastic Waste Management (PWM) e.g. Collection, Segregation, Disposal (Co-processing road construction etc.) (Rules 6) (Attach separate	Partial or complete ban on usages of Plastic Carry Bags (through Executive Order) (Attach copy of notification or executive order)	Status of Marking Labelling on carry bags (Rule 8) [Specify the number of units or not complied)complied	Explicit Pricing of carry bags (Rule 10)	Details of the meeting of State Level Advisory Body (SLA) along with its recommend-dations on Implemen-tation (Rule 11)	No. of violations and action taken on non-compliance of provisions of these Rules	Number of Municipal Authority or Gram Panchayat-under jurisdiction and Submission of Annual Report to CPCB (Rule 12)
		Plastic units	Compostable Plastic Units	Multilayer Plastic units								

	Facility-II i) Name of operator ii) Address with Telephone Number or Mobile iii) Capacity iv) Technology Used v) Registration Number Validity of Registration (up to)	
(19)	Give details of: Local body's own manpower deployed for collection including street sweeping, secondary storage, transportation, processing and disposal of waste.	
(20)	Give details of: Contractor or concessionaire's manpower deployed for collection including street sweeping, secondary storage, transportation, processing and disposal of waste.	
(21)	Mention briefly, the difficulties being experienced by the local body in complying with provisions of these rules including the financial constrains, if any	
(22)	Whether an Action Plan has been prepared for improving solid waste management practices in the city? If yes (attach copy) Date of revision:	

Signature of CEO or Municipal Commissioner or

Executive Officer or Chief Officer

Date:

Place:

Form-VI

STATE-WISE STATUS OF IMPLEMENTATION OF PLASTIC WASTE MANAGEMENT RULES, 2016 FOR THE YEAR … ANNUAL REPORT Format

						sheet)						
(1)	(2)	(3)			(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)

[F. No. 17-2/2001-HSMD]

BISHWANATH SINHA, Jt. Secy.

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पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय

अधिसूचना

नई दिल्ली, 27 मार्च, 2018

सा.का.नि. 285(अ).—केन्द्रीय सरकार, पर्यावरण (संरक्षण) नियम, 1986 के नियम 5 के उप नियम (4) के साथ पठित पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 6, धारा 8 और धारा 25 द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए, भारत के राजपत्र, असाधारण में सा.का.नि. 320(अ) तारीख 18 मार्च, 2016 के द्वारा प्रकाशित, अपशिष्ट प्लास्टिक नियम, 2016 का, पूर्वोक्त नियमों के नियम 5 के उप नियम (3) के खंड (क) के अधीन सूचना की अपेक्षा को, लोकहित में अभिमुक्त करने के पश्चात, संशोधन करने के लिए निम्नलिखित नियम बनाती है, अर्थात् :-

1. (1) इन नियमों का संक्षिप्त नाम अपशिष्ट प्लास्टिक प्रबंधन (संशोधन) नियम, 2018 है।

(2) ये राजपत्र में इनके प्रकाशन की तारीख से प्रवृत्त होंगे।

2. अपशिष्ट प्लास्टिक प्रबंधन नियम, 2016 जिसे इसमें इसके पश्चात् उक्त नियम कहा गया है, के नियम 3 में,-

i खंड (क) के पश्चात् निम्नलिखित खंड अंत:स्थापित किया जाएगा :-

"(क ख) 'अनुकल्पिक उपयोग' से किसी सामग्री का उस प्रयोजन से भिन्न, जिसके लिए उसकी परिकल्पना की गई थी, ऐसा उपयोग अभिप्रेत है, जो इसलिए फायदाप्रद है, क्योंकि इससे संसाधन कार्य कुशलता में अभिवृद्धि होती है।";

(ii) खंड (छ) के पश्चात् निम्नलिखित खंड अंत:स्थापित किया जाएगा अर्थात् :-

"(छ क)" 'ऊर्जा की पुन: प्राप्ति' से अपशिष्ट से ऊर्जा की पुन: प्राप्ति अभिप्रेत है, जो कि विभिन्न प्रक्रियाओं, जिनके अंतर्गत दहन, गैसीयकरण, उत्ताप विच्छेदन (पाइरोलाइजेशन), निर्वात उपचारण (एनेरोबिक डाइजेशन) और खत्ते से गैस की पुन: प्राप्ति भी हैं, के माध्यम से अपशिष्ट माल का प्रयोग योग्य उष्मा, विद्युत या ईंधन में संपरिवर्तन किया जाना है;"।

3. उक्त नियमों के नियम 9 के, उप नियम (3) में "पुन:चक्रीकरण न की जा सकने योग्य बहुस्तरीय पैकेजिंग का विनिर्माण एवं उपयोग, यदि कोई हो" के स्थान पर, बहुसतहीय प्लास्टिक, जो गैर पुन:चक्रणीय हो या जिससे पुन: ऊर्जा प्राप्त न की जा सके, या जिसका कोई अनुकल्पिक उपयोग न हो" शब्द रखे जाएंगे।

4. उक्त नियमों के नियम 13 के उप नियम (2) के स्थान पर निम्नलिखित उप नियम रखा जाएगा, अर्थात :-

"(2) प्रत्येक उत्पादक या ब्राण्ड – स्वामी रजिस्ट्रीकरण या रजिस्ट्रीकरण के नवीकरण के प्रयोजन के लिए प्ररूप 1 में,-

(i) संबद्ध राज्य प्रदूषण नियंत्रण बोर्ड या संघ राज्य क्षेत्र की प्रदूषण नियंत्रण समिति यदि एक या दो राज्यों या संघ राज्य क्षेत्रों में क्रियाशील है; या

(ii) केन्द्रीय प्रदूषण नियंत्रण बोर्ड, यदि दो से अधिक राज्यों या संघ राज्य क्षेत्रों में क्रियाशील है, को आवेदन करेगा।

5. उक्त नियमों के नियम 15 का लोप किया जायेगा।

[फा.सं. 17-2/2001-एचएसएमडी]

रितेश कुमार सिंह, संयुक्त सचिव

टिप्पण : मूल नियम, भारत के राजपत्र, असाधारण, भाग II, खंड 3, उप खंड (i) में *संख्यांक* सा.का.नि. 320(अ) तारीख 18 मार्च, 2016 द्वारा प्रकाशित किये गये थे।

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 27th March, 2018

G.S.R. 285(E).—In exercise of powers confirmed by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), read with sub-rule (4) of rule 5 of the Environment (Protection) Rules, 1986, the Central Government hereby makes the following rules to amend the Plastic Waste Management Rules, 2016, published in the Gazette of India, Extraordinary, vide number G.S.R. 320(E), dated the 18th March, 2016, after having dispensed with the requirement of notice under clause (a) of sub-rule (3) of rule 5 of the aforesaid rules in public interest, namely :-

1. (1) These rules may be called Plastic Waste Management (Amendment) Rules, 2018.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Plastic Waste Management Rules, 2016 (hereinafter referred to as the said rules), in rule 3,-

i. after clause (a), the following clause shall be inserted, namely:-

"(ab) 'alternate use' means use of a material for a purpose other than for which it was conceived, which is beneficial because it promotes resource efficiency;";

ii. after clause (g), the following clause shall be inserted, namely:-

"(ga) 'energy recovery' means energy recovery from waste that is conversion of waste material into usable heat, electricity or fuel through a variety of processes including combustion, gasification, pyrolisation, anaerobic digestion and land fill gas recovery:".

3. In the said rules, in rule 9, in sub-rule (3), for the words "non-recyclable multilayered plastic if any", the words "multi-layered plastic which is non-recyclable or non-energy recoverable or with no alternate use" shall be substituted.

4. In the said rules, in rule 13, for the sub-rule (2) the following sub-rule shall be substituted, namely: -

"(2) Every producer or brand-owner shall, for the purpose of registration or renewal of registration, make an application, in Form 1 to,-

(i) the concerned State Pollution Control Board or Pollution Control Committee of the Union territory, if operating in one or two states or Union territories; or

(ii) the Central Pollution Control Board, if operating in more than two States or Union Territories.".

5. In the said rules, the rule 15 shall be omitted.

[F. No. 17-2/2001-HSMD]

RITESH KUMAR SINGH, Jt. Secy.

Note : The principal rules were published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section (i), *vide* number GSR 320(E), dated the 18th March, 2016.

RAKESH SUKUL Digitally signed by RAKESH SUKUL Date: 2018.03.31 12:47:34 +05'30'

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MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 12th August, 2021

G.S.R. 571(E).—Whereas the draft rules to amend the Plastics Waste Management Rules, 2016, were published in the Gazette of India, Extraordinary, dated the 11th March, 2021 vide notification number GSR 169 (E), inviting objections and suggestions from all persons likely to be affected thereby within a period of sixty days from the date copies of the Gazette containing the said draft rules were made available to the public;

And whereas, copies of the Gazette containing the said draft rules were made available to the public on the 11th March, 2021;

And whereas, objections and suggestions received within the aforesaid period have been duly considered by the Central Government;

Now, therefore, in exercise of the powers conferred by sections 6, 8 and 25 of Environment (Protection) Act 1986, (29 of 1986), the Central Government hereby makes the following rules to amend the Plastic Waste Management Rules, 2016, namely :-

1. (1) These rules may be called Plastic Waste Management (Amendment) Rules, 2021.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Plastic Waste Management Rules,2016 (hereinafter referred to as the said rules), in rule 2, in sub-rule (1), after the word "Importers", the words, "brand-owner, plastic waste processor (recycler, co-processor, etc.)" shall be inserted.

3. In the said rules, in rule 3,

(i) after clause (n), the following clause shall be inserted, namely :-

'(na) "Non-woven plastic bag" means Non-woven plastic bag made up of plastic sheet or web structured fabric of entangled plastic fibers or filaments (and by perforating films) bonded together by mechanical or thermal or chemical means, and the "non-woven fabric" means a flat or tufted porous sheet that is made directly from plastic fibres, molten plastic or plastic films;'

(ii) after clause (q), the following clause shall be inserted, namely: -

'(qa) "Plastic waste processing" means any process by which plastic waste is handled for the purpose of reuse, recycling, co-processing or transformation into new products;'

(iii) after clause (v), the following clauses shall be inserted, namely: -

'(va) "Single-use plastic commodity" mean a plastic item intended to be used once for the same purpose before being disposed of or recycled;'

'(vb) "Thermoset plastic" means a plastic which becomes irreversibly rigid when heated and hence cannot be remoulded into desired shape;'

'(vc) "Thermoplastic" means a plastic which softens on heating and can be moulded into desired shape;'.

4. In the said rules, in rule 4, -

(a) in sub-rule (1),–

(i) for the words "importer stocking", the words "import, stocking" shall be substituted;

(ii) in clause (c), for the words "fifty microns in thickness" , the words, figures, letters and brackets "seventy five microns in thickness with effect from the 30th September, 2021and one hundred and twenty (120) microns in thickness with effect from the 31st December, 2022" shall be substituted;

(iii) in clause (h), after the words, "carry bags", the words "and commodities" shall be inserted;

(iv) in clause (h), after the words, "compostable plastic carry bags", the words "or commodities or both" shall be inserted;

(v) after clause (i), following clause shall be inserted, namely: -

" (j) non-woven plastic carry bag shall not be less than 60 Gram Per Square Meter (GSM) with effect from the 30th September, 2021.";

(b) after sub-rule (1), the following sub-ules shall be inserted, namely:-

"(2) The manufacture, import, stocking, distribution, sale and use of following single-use plastic, including polystyrene and expanded polystyrene, commodities shall be prohibited with effect from the 1st July, 2022:-

(a) ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, polystyrene [Thermocol] for decoration;

(b) plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping or packing films around sweet boxes, invitation cards, and cigarette packets, plastic or PVC banners less than 100 micron, stirrers.

(3) The provisions of sub-rule (2) (b) shall not apply to commodities made of compostable plastic.

(4) Any notification prohibiting the manufacture, import, stocking, distribution, sale and use of carry bags, plastic sheets or like, or cover made of plastic sheets and multi-layered packaging and single-use plastic, including polystyrene and expanded polystyrene, commodities, issued after this notification, shall come into force after the expiry of ten years, from the date of its publication".

5. In the said rules, in rule 5, in sub-rule (1), in clause (d), for the figures "2000", the figures "2016" shall be substituted.

6. In the said rules, in rule 6, in sub-rule (2), after clause (a), following clause shall be inserted, namely: -

"(aa) ensuring that the provisions of these rules, as amended, are adhered to;".

7. In the said rules, in rule 7, in sub-rule (1), after clause (a), following clause shall be inserted, namely : -

"(aa) ensuring that the provisions of these rules, as amended, are adhered to;".

8. In the said rules, in rule 9, in sub-rule (1), after the words, "local body concerned", the words "as per guidelines issued under these rules from time to time" shall be inserted.

9. In rule 11, sub-rule (1), –

(i) after the words "plastic carry bag", the words, "plastic packaging" shall be inserted;

(ii) in clause (a), after the word "manufacturer", the words "producer or brand-owner" shall be inserted, and after the words "carry bag", the words "and plastic packaging used by the brand owner" shall be inserted;

(iii) in clause (b), after the words "multilayered packaging", the words "excluding multi-layered packaging used for imported goods" shall be inserted;

(iv) in clause (c), after the words "name and certificate number", the words "of producer" shall be inserted.

10. In rule 12, –

(i) in sub-rule (2), after the words "waste generator," ,the words "restriction or prohibition on" shall be inserted;

(ii) in sub-rule (3), after the words "waste generator," ,the words "

restriction or prohibition on" shall be inserted.

11. In rule 13, in sub-rule (1), after the words "Union Territory concerned", the words "or the Central Pollution Control Board" shall be inserted.

[F. No. 17-2-2001 (Pt)-Part I -HSMD]

NARESH PAL GANGAWAR, Jt. Secy.

Note : The principal rules were published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section (i), *vide* number GSR 320 (E), dated the 18th March, 2016 and subsequently amended vide notification number GSR 285 (E), dated the 27th March, 2018.

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27960/2022/UPC-II-HO
[भाग II—खण्ड 3(i)] भारत का राजपत्र : असाधारण 7

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 18th January, 2022

G.S.R. 22(E).—The following draft notification which the Central Government proposes to issue, in exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), for making certain amendments in the Plastic Waste Management Rules, 2016, issued vide G.S.R. 320 (E), dated the 18th March, 2016, is hereby published as required under sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, for information of the public likely to be affected thereby and notice is hereby given that the said notification will be taken into consideration by the Central Government on or after the expiry of sixty days from the date on which copies of this notification as published in the Gazette of India are made available to the public;

Any person interested in making any objection or suggestion on the proposals contained in the draft notification may do so in writing within the period so specified through post to the Secretary, Ministry of Environment, Forest & Climate Change, Indira Paryavaran Bhawan, Jor Bagh Road, Aliganj, New Delhi-110003 or electronically at email address: satyendra.kumar07@nic.in, amit.love@nic.in.

Draft Notification

Whereas, the Plastic Waste Management Rules, 2016 were notified by Ministry of Environment, Forest and Climate Change vide G.S.R. 320 (E), dated the 18th March, 2016, inter alia, providing for collection, segregation, processing, treatment and disposal of the plastic waste in an environmentally sound manner, restriction on thickness of plastic sheet or like, prohibition on identified use, extended producer responsibility, marking and labelling requirement, registration of manufacturer, producer, importer, brand owner and plastic waste processor, reducing the plastic waste generation;

Whereas, the Plastic Waste Amendment Rules, 2021, were notified vide G.S.R. No. 571 (E) on 12th August, 2021, inter alia, providing for issuance of Guidelines under Rule 9 (1) on the responsibility of producer, importer and brand owner;

And whereas, the Ministry of Environment, Forest and Climate Change notified the draft provisions for the "Regulation on the Extended Producer Responsibility under Plastic Waste Management Rules, 2016, as amended from time to time" vide GSR No. 722 (E) on 6th October, 2021;

And whereas, the principle of sustainable development, precautionary principle, and polluter pays principle have been recognized in the law;

Now, therefore, in the exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), read with clause (d) of sub-rule (3) of rule 5 of the said Environment (Protection) Rules, 1986 the Central Government hereby publishes this draft notification as required under sub-rule 3 of rule 5 of the said Environment (Protection) Rules, 1986, which shall on and from the date of its final publication make the following amendments in the said notification, namely:—

1. (1) These rules may be called Plastic Waste Management Rules, 2022.

   (2) They shall come into force on the date of their publication in the Official Gazette.

2. In the said rules, in rule 3,

   i. After clause (ab), the following clause shall be inserted, maely:-

   '(ac) "Biodegradable plastics" means that plastics, other than compostable plastics, which undergoes complete degradation by biological processes under ambient environment (terrestrial or in water) conditions, in specified time periods, without leaving any micro plastics, or visible, distinguishable or toxic residue, which has adverse environment impacts, adhering to laid down standards of Bureau of Indian Standards and certified by Central Pollution Control Board.'

   ii. Clause 3(b), may be read as given below:-

   '"Brand Owner" means a person or company who sells any commodity under a registered brand label/trademark;'

   iii. after clause 3 (g), the following clause shall be inserted namely :-

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'(gb) "End of Life disposal" means using plastic waste for generation of energy which includes co-processing (e.g. in cement kilns) or waste to oil or for road construction as per Indian Road Congress guidelines and other relevant guidelines;'

iv Clause 3(k), may be read as given below:-

' "Importer" means a person who imports plastic packaging product or products with plastic packaging or carry bags or multilayered packaging or plastic sheets or like;'

v. after clause 3 (o), the following clause shall be inserted namely :-

'"Plastic Packaging" means packaging material made by using plastics for protecting, preserving, storing and transporting of products in a variety of ways;'

vi. after Clause 3(qa), the following clause shall be inserted namely :-

'(qb) "Plastic Waste Processors" means recyclers and entities engaged in using plastic for energy (waste to energy) including in coprocessing or converting it to oil (waste to oil), industrial composting;'

vii. after Clause 3(qb), the following clause shall be inserted namely:-

'(qc) "Post-consumer plastic packaging waste" means plastic packaging waste generated by the end-use consumer after the intended use of packaging is completed and is no longer being used for its intended purpose;'

viii. after Clause 3(r), the following clause shall be inserted namely:-

'(ra) "Pre-consumer plastic packaging waste" means plastic packaging waste generated in the form of reject or discard at the stage of manufacturing of plastic packaging and plastic packaging waste generated during the packaging of product including reject, discard, before the plastic packaging reaches the end-use consumer of the product;'

ix. after Clause 3(s), the following clause shall be inserted namely :-

'(sa) "Recyclers" are entities who are engaged in the process of recycling of plastic waste;'

x. after Clause 3(w), the following clause shall be inserted namely :-

'(wa) "Use of recycled plastic" means recycled plastic, instead of virgin plastic, is used as raw material in the manufacturing process;'

xi. after Clause 3(aa), the following clause shall be inserted namely :-

'(aab) "Waste to Energy" means using plastic waste for generation of energy and includes co-processing (e.g. in cement kilns);'

3. In the said rules, in rule 4, -

i. in sub-rule (1), in clause (d), after the words " thickness except", the words shall be inserted " as notified by Government"

4. In the said rules, in rule 9, -

i. for the sub-rule (1), the following sub-rule shall be substituted, namely.-

"The Producers, Importers and Brand Owners, shall fulfill Extended Producers Responsibility on plastic packaging waste as per regulations issued under these rules from time to time"

ii. in the sub-rule (4), before the words, "Pollution Control Board", the words, "Central Pollution Control Board and State" is inserted

iii. in the sub-rule (5), after the words "without registration from" the following words are added "Central Pollution Control Board if operating in more than two states or union territories" and after the words "Pollution Control Committees" the following words are added " as per sub-rule 13 (2)."

5. In the said rules, for rule 10, the following sub-rule shall be substituted, namely.-

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"10. Protocols for compostable and biodegradable plastic materials.-Determination of the degree of degradability and degree of disintegration of plastic material shall be as per the protocols of the Indian Standards listed in Schedule I to these rules, wherein, it shall be ensured that standard biodegradable plastic, other than compostable plastics, undergoes complete degradation by biological processes under ambient environment (terrestrial or in water) conditions, in specified time periods, without leaving any micro plastics, or visible, distinguishable or toxic residue, which has adverse environment impacts, following appropriate standards developed by Bureau of Indian Standards and certified by Central Pollution Control Board. The compostable plastic materials shall conform to the Indian Standard: IS 17088:2008 titled as Specifications for Compostable Plastics, as amended from time to time."

6. In the said rules, in rule 11-

i. In sub rule 11, "plastic packaging" are substituted by the words "plastic sheet or like used for packaging"

ii. In sub-rule (1) clause (a), words "manufacturer" and "used by the brand owner" shall be omitted and words "plastic packaging" are substituted by the words "plastic sheet or like used for packaging" and after words "plastic sheet or like used for packaging" the following words are added "with effect from 1st July, 2022 and excluding plastic sheet or like used for packaging used for imported goods. Nothing contained in this proviso shall apply to "plastic sheet or like used for packaging" in cases exempted under Rule 26 of Legal Metrology Packaged Commodities Rules, 2011."

iii. In sub rule (1) clause (b), the word "manufacturer" shall be substituted by the word "producer or brand owner" , the word "and" is substituted with the following words "with effect from 1st July, 2022"

iv. After sub-rule (1) clause (c), the following clause if inserted

"(d) The importer or brand owner, of imported carry bags or multi-layered packaging or plastic sheets or like used for packaging, alone or along with products shall adhere to Sub-rule 11 (a) and 11 (b)."

7. In the said rules, in rule 12, -

i. In Sub-rule (1), before the words, "State Pollution Control Board", the words, "Central Pollution Control Board" is inserted.

8. In the said rules, in rule 13, -

i. for the sub-rule (1), the following sub-rule shall be substituted, namely.-

"(1) No person shall manufacture carry bags or recycle plastic or multilayered packaging unless the person has obtained registration from,-

i. The concerned State Pollution Control Board or Pollution Control Committee of the Union Territory, if operating in one or two states or Union territories; or

ii. The Central Pollution Control Board, if operating in more than two States or Union Territories,"

ii. in sub-rule (2), after the word "producer" the following word is added "importer" and after the "to" the following words are added "as per the procedure prescribed under Regulation for Extended Producer Responsibility issued under Rule 9 (1)."

iii. in sub-rule (3), after the words "in Form II" the following words are added "as per the procedure prescribed under Regulation for Extended Producer Responsibility issued under Rule 9 (1)."

iv. Sub-rule (6) shall be omitted.

v. In the sub-rule (7), after the words "terms of registration." the following words are added "The registration shall be subject to every person recycling or processing plastic waste or

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proposing to recycle or process plastic waste, adhering to the Regulation for Extended Producer Responsibility issued under Rules 9 (1), as applicable."

9. In the said rules, after rule 17, a new rule 18 is added as given below:

"18. Imposition of Environmental Compensation.-

1. Environmental Compensation shall be levied based upon polluter pays principle, on person(s) not adhering to the provisions of these rules, for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environment pollution.

2. CPCB shall lay down guidelines for imposition and collection of environment compensation and the same shall be notified. The Guidelines for Environmental Compensation shall be updated, as required."

10. In the said rules, in Form I

(i). in Part I at item 11, the following shall be substituted, namely.-

"Action plan as per Regulation notified for Extended Producer Responsibility"

(ii) in Part II at item 9, the following shall be substituted, namely.-

"Action plan as per Regulation notified for Extended Producer Responsibility"

(iii) After Part II, the following is added:

III. Importers:

Item 3, 4, 5 of Part A, Part B, and item 7 and 8 of Part C, to be filled as per applicability.

PART – A GENERAL		
1.	Name, Address and Contact number	
2	In case of renewal, previous registration number and date of registration	
3	Is the unit registered with the District Industries Centre of the State Government or Union Territory? If yes, attach a copy.	
4.(a)	Total capital invested on the project	
(b)	Year of commencement of production	
5. (a)	List and quantum of products and by-products	
(b)	List and quantum of raw materials used	
6 (a)	Quantity of plastic sheet or like used for packaging of imported or to be imported products	
(b)	Quantity of imported or to be imported plastic sheet or like used for packaging for further supply or self-use	
(c)	Quantity of imported or to be imported multilayered packaging for further supply or self-use	
PART – B PERTAINING TO LIQUID EFFLUENT AND GASEOUS EMISSIONS		
5	Does the unit have a valid consent under the Water (Prevention and control of Pollution) Act, 1974 (6 of 1974)? If yes, attach a copy	
6	Does the unit have a valid consent under the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981)? If yes, attach a copy	

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	PART – C PERTAINING TO WASTE	
7.	Solid Wastes or rejects: c. Total quantum of waste generated d. Mode of storage within the plant (d) Provision made for disposal of wastes	
8. (a)	Attach or Provide list of person supplying imported (i) plastic sheet or like used for packaging, (ii) multilayered packaging	
(b)	Quantity of imported (i) plastic sheet or like used for packaging, (ii) multilayered packaging used for self use	
9	Action plan as per Regulation notified for Extended Producer Responsibility	
	Name and Signature Designation Date : Place :	

11. In the said rules, in Form IV, the following is added after item (9)

"(10). Data to be provided as per Regulation on Extended Producer Responsibility issued under Rule 9 (1) by the 30th April of every year to the concerned State Pollution Control Board and Pollution Control Committee"

12. In the said rules, in Form VI, the following is added after the table

"B. Information as prescribed with respect to Regulation under Extended Producer Responsibility issued under Rule 9 (1) to be provided by 30th April of every year in the prescribed pro forma to Central Pollution Control Board for the following:

a. Manufacturer of carry bag, recycle plastic bag, multilayered packaging (Registered under Rule 13 (1) (i))

b. Producer, Importer, Brand Owner (Registered under Rule 13 (2) (i))

c. Recycler and plastic waste processor (Registered under Rule 13 (3) (i))"

[F. No. 17/24/2021-HSMD]

NARESH PAL GANGAWAR, Jt. Secy.

Note : The principal rules were published in the Gazette of India, vide number G.S.R 320 (E), dated the 18th March, 2016 and subsequently amended vide notification number G.S.R 285 (E), dated the 27th March, 2018 and subsequently amended vide notification number G.S.R. 571 (E), dated the 12th August, 2021 and last amended vide notification number G.S.R. 647(E), dated the 17th August, 2021.

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