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BEAT PLASTIC POLLUTION

WORLD ENVIRONMENT DAY - 2023

SOLUTIONS TO PLASTIC POLLUTION

State EIACP Hub
Centre for Environmental Studies
Forest & Environment Department
Government of Odisha, Bhubaneswar

Solutions to Plastic Pollution

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PREFACE

The mounting challenge of plastic wastes worldwide, including its cascading impact on vulnerable marine and terrestrial ecosystems, has spurred the challenging quest for viable alternatives as part of present generation think tankto deal with the crisis. Decades of relentless use of plastics across our economies has led to a seemingly unstoppable flow of plastics into the environment which has been compounded by unsustainable production, consumption patterns & inadequate waste management.

Plastic pollution awareness is now at an all-time high and the last few years have seen a continuous stream of news headlines about plastic pollution, campaigns, and innovations that could potentially help society reinvent and redefine its relationship with plastic. Awareness is starting to translate into action and impact, with many institutions and citizens considering their plastic footprint, consumers calling for a plastic-free revolution and governments around the world teetering on the edge of implementing policy and legislation that could reduce the plastic burden on our planet.

Still, in developing countries like India, many people are clueless as to how to curb plastic usage or what to do with plastics or where to start from. To address this dilemma, State EIACP Hub, Centre for Environmental Studies (CES) has come across an innovative idea to compile a book wherein the intelligentsia of the state have put forth their understandings, views, suggestions and way-forward towards plastics and our future. Further, the efforts and suggestions of our master trainers of the Eco-clubs, who are truly the foot soldiers in the war against plastics and harbingers of change, also from the pages this book. While the in-depth write-ups of eminent scientists, educationists and environmentalists are sure to enhance our knowledge and understanding of the subject, thepersonal experiences of the master-trainers in dealing with plastic wastes, taking the challenges head on for making the campus plastic free, adopting alternatives to plastics and their valuable suggestions will definitely nudge the common reader towards a plastic-free lifestyle and will serve as a beacon light towards a sustainable life.

If you've been wondering what you can do about the plastic pollution crisis, this compendium is the book to dive into. It provides a comprehensive understanding of plastics and a really simple format for reducing plastic where you work, plus lots of invaluable advice for overcoming any challenges, so you have all the tools you need to start a positive wave of change in your locality.

It is hoped that this extraordinary effort of the Odisha EIACP Hub in conjunction with intellectuals and the master trainers of the state will serve its purpose of disseminating knowledge, creating more and more awareness and inflict a surgical strike on the plastic demon.

(K. Murugesan)

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BEAT PLASTIC POLLUTION

Dr. Bijay Ketan Patnaik, IFS (Retd.)
Former PCCF (Wildlife), Govt. Of Odisha

Plastic population is one of the greatest threats to Earth with far reaching impact on environment. More than 400 million tons of plastic is produced every year in the world, half of which is designated to be used only once and then thrown away. Because plastic is non biodegradable and takes 500 to 1000 years to get degraded, the world including ocean is now inundated by plastic. Plastic can wreak slow but certain havoc on environment in multiple ways, from leaching toxic chemicals in to the soil and ground water to directly chocking or poisioning animals who unwittingly ingest it. Because of various adoptable and easy to use nature of plastic and because of our indulgence and dependence on plastic, the demand as well as production of plastic grew by 79% between 2000 to 2015. Presently the total quantity of plastic on the planet is already twice over the mass of all livings animals on earth. Hence the problem of plastic disposal in quite enormous. That is why, the theme of world environment Day (WED), 2023, has been kept "Solution to plastic pollution." Five years beck, the theme of WED was also "Beat Plastic Pollution."

Mass use of plastic is only a matter of 3 to 4 decades. Also the production of plastic has increased many folds in the last and recent decades- largely a consequence of globalization and the rise of 'throw away culture'. Since 1950, humans have produced more than 8 billion tons of plastic, more than half of which went to straight to landfills and only about 9% of which was recycled. Larger and more populous countries like India and china, producing 26.33 and 21.60 percent of waste annually, that accounts for nearly 50 percent of global plastic waste. However the per capita consumption in India in much lower (11kg per capita per annum), compared to global overage (28 Kg) and the per capita consumption in the developed countries such as United states is (139 Kg/annum).

To end plastic pollution, a slogan is often raised, "Say No to Plastic". But is it practicable ? A year back, in a seminar organized at Ravenshaw University, the vice chancellor of the university said and I quote – "Do not say No to plastic, but say No to Single use plastic. This is because we have became so accustomed in using plastic in all walks of our life, that it is practically impossible to say 'Bye' to plastics of all types. But, certainly we can emphatically say 'No' to Single use plastic. According to UN Environmental Programme (UNEP), globally of the total polymer produced every year, about 50 per cent is used in making single use plastic items. In India of the 3.5 million tones of plastic waste generated every year around 2.8 million tones or 68 percent are of single use.

What are single use plastic?

Any plastic material which is used once for utility and is disposed right away classifies as single use plastic. To be more simple, it is that plastic which is produced and designed to be thrown away after being used only once. As per the U.N., the most common single use plastics world wide include items such as cigarette butts, plastic bottles and their caps, straws, stirrers, food wrappers, carry bags and disposable crockery, plastic flowers and thermo cool decorative materials. Plastic packaging accounts for nearly half of all the plastic wastes in India, which are thrown away within just a few minutes of its first use. A recent study has shown that in India, carry bags (35.53%) and straws (22.37%) accounts for more than half of the banned products still in circulation. Plastic cutlery mostly used in various marriages and other functions also accounts for 18.42 per cent of single use plastic.

Rules and regulations:

For management of plastic waste, under environmental protection, 1986, there is a specific rule called 'Recycled plastic waste management and Usage Rules, 1999.' According to this 1999 rule, the thickness of the recycled polythene should not be less than 20 micron (1 micron = one thousandth of a millimeter) and the color to be used should be permissible.

Basing on that rule in our state Odisha, on 31st December 2003; a notification was issued stating that nobody in the state, will manufacture and sale polythene bags of thickness less than 20 micron and in 2004, a comprehensive ban was imposed on use of polythene of less thickness in the entire state. But prior to that in 2001 itself, our state banned use of polythene carry bags of any thickness in important tourist places like Puri, Kornark, Chilika, Sea beaches, Sanctuaries such as Simlipal and Bhitarkanika and Nandankanan. Again during 2011, some modifications were made in the previous notification and banned polythene of less than 40micron thickness in all municipality limits. Further in 2016,ban on plastic was extended up to 50 micron thickness and the rule was made applicable to both municipality in urban areas as well as rural areas.

On 5th June 2018, to mark the world environment day with slogan "Beat Plastic Pollution", our Prime Minister (PM) asserted that India would phase out single-use plastic by 2022. During 2018, the World Environment Congress was held in India. On August 5, 2019 PM on his Independence Day address to nation, reiterated his earlier commitment and urged the citizens to "Free the country from single-use plastic" .That same year on October 2, as the country was observing the 150th birth anniversary of Mahatma Gandhi, the PM urged for a mass movement to eradicate single-use plastics. Following Govt. Of India's notification, our state government also banned the use of polythene of less than 50micron thickness and other single-use plastic items, first in five municipal corporation limits like Bhubaneswar, Cuttack, Berhampur, Sambalpur, Rourkela and Puri municipality. Later on the same restriction was imposed over the entire state.

Last year , in 2022, basing on the discussion held in the Environment Conference of UN, India prohibited the manufacture, import, stocking, distribution, sales and use of 19 identified single use plastic items with low utility and high littering potential. The ban came into force from 1st of July,

2022 and in the same notification, it was stated to further ban use of polythene less than 120 micron thickness from 31st December 2022. But , in spite of all these legal restrictions, the use of polythene carry bags still going on unabatedly.

4 R :

Since the problem is mammoth , there is no single solution for tackling this issue. Previously one approach of 4 R was developed to handle the plastic pollution problem. They are

i. R-Reduce

ii. R-Recover

iii. R-Recycle

iv. R-Reuse

Later on another R was also added to the list i.e v. R-Refuse

Reduce or refuse the use of plastic depends entirely on One's individual mindset. I have recently seen in many cultural functions when guest on the dias are offered with flower bouquet, wrapped with plastic, they politely refuse to accept it. Fifteen years back, as Director , Environment of State, I had once gone to visit and Eco club in Sunabeda Girls High School, Koraput. There, an Eco club member, a 10th class student said that, they have asked their mothers to provide either a cloth bag or jute bag, whenever their father goes to market either to buy vegetable or grocery, so that they did not bring polythene carry bag to home. This should be the attitude of each individual and each family. But even after that so much awareness campaign, even after the intervention of law implementing machinery, every morning, while sitting in my balcony, I usually find many senior citizens, returning from their morning walk invariably carry a polythene bag studded with vegetables and fruits. Change should come from within and not by enforcement of law only.

Frankly speaking, the enforcement mechanism is not up to the mark to ensure the closure of units into production and manufacturing the banned items. Penalty is imposed on retailers and street vendors, but the producers and wholesale distributors often go scot free. The other challenge is lack of alternatives to plastics in the market. It may be argued that the substitutes are wood, paper, glass, rice and wheat barn baggage, plant materials such as Sal, Bauhinia or Coconut leave, bamboo, coconut shell for growing seedlings, compostable plastic etc. However , currently substitutes in such a large volume and comparative price are not widely available. The next hurdle comes in providing alternative work opportunities to thousands of workers involved or engaged in producing single-use plastic. The fourth problem comes from implementing other two R's i.e Recover and Recycle. Waste pickers are the largest workforce engaged in the recycle chain and recover a higher proportion of recyclable materials than our formal waste management system. They need a rehabilitation scheme for their sustenance. Last but not the least, alternate use of plastic waste in road construction, cement production or suitable technology for converting waste to wealth may also be explored.

How and from where we can start?

a) Phase wise ban on single use plastics and micro beads as urgently as possible

b) Start a deposit and return scheme through a proper buy back system of milk pouches, uncontaminated PET bottles, etc.

c) Invest in alternatives. The government should finance on more research and development of alternate materials

d) Implementation of EPR(Extended Producer Responsibility). It is time that the Industry shares the onus of plastic waste management.

e) Public awareness and participation of citizens,Consumers must be encouraged to use eco friendly products ,reusable water bottles and containers, washable plates, cups and cutlery etc. Segregation of plastic waste at the origin point must also be put in practice

A ray of hope could be seen, when on March 2,2022, representatives from 175 countries meeting at the 5th session of the UN Environment Assembly in Nairobi,Kenya agreed to end plastic pollution and formulate an international treaty by 2024. It is said that the treaty will be legally binding and implementable. Let us hope for the best and keep our fingers crossed!

PLASTICS WASTE:
ENVIRONMENT IMPACT AND MANAGEMENT

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The urban population in India has grown at a faster rate during last decades whereas the growth rate of total population is about 2%. The urban population is increasing at a rate of 3-4% and the rural at a rate of 1-1.5%. The total number of urban centres has increased to more than 3800 (with a population of 217 million people) whereas number of cities increased from 218 to 291. Number of metropolitan cities (inhabiting population more than 1 million) has increased from 12 to more than 30 accounting for about half of the total urban population in India. The cities of Bombay, Kolkata, Delhi and Chennai together accommodate more than 37 million populations. The main reason for increase in the urbanization is the migration of rural population into the towns/ cities/metropolitan cities for the employment as urban population (26%) generates 40% of the National Domestic Product (NDP) due to better educational, medical and other infrastructural facilities. Unprecedented growth in urban areas and particularly in metropolitan cities have put tremendous pressure on housing, water and power supply and water and air quality resulting in deterioration of environmental quality. The solid waste generated in these urban areas is of major concern. Solid waste, in general, can be classified into various categories. Rapid population growth, urbanization and industrial growth have led to severe problems of waste management in urban centres. To keep the streets clean, collection of garbage from public places and to ensure its safe disposal, fairly large number of employees are engaged by concerned organizations. Yet, only about half to two-thirds of the waste generated is collected with present system.

Urban India produces about 42.0 million tons of municipal solid waste annually i.e. 1.15 lakh metric tons per day (TPD), out of which waste generated in Class-I cities works out to 72.5% of the total waste generated each day and this needs to be tackled on priority. Each of the urban residents generates 350 to 1000 g solid waste every day. Taking waste from commercial and industrial establishments, the total waste generation/day adds up to an enormous quantity. With increasing population and rising income, the lifestyle of urban residents is also changing. Urban India is thus becoming a "throw -away society". The wastes in bigger cities are generally paper, plastic, metal and hazardous materials apart from vegetable wastes. Biodegradable household waste has far less impact than the waste generated by activities like manufacturing of goods. The industrialization and high level of affluence also influence the composition and quantity of waste. More than 80% of the typical family's waste comprises biodegradable materials. There exists a direct link between affluence and municipal waste. There has been increase in the Gross Domestic Product (GDP) in countries of Organization for Economic Cooperation and Development (OECD) by 40% with similar increase in municipal wastes. With this link between waste generation and GDP continuing, more effort shall be required in managing the urban solid wastes.

As far as the management aspects of solid wastes are concerned, the following possibilities are of significance to us:

1. Reduction in raw material use.
2. Reduction in generation solid waste quantities.
3. Reuse of solid waste materials.
4. Recovery of materials/metals.
5. Generation of energy/biogas.
6. Conversion into useful products such as fertilizers, fuel pellets etc.
7. Reduction in quantity of solid wastes through incineration/pyrolysis
8. Disposal of solid wastes (land filling).

The plastics wastes and management

The plastics products viz., carry bags, blood bags, coloured plastic pots are fast becoming popular in both rural and urban India. The packaging and poly vinyl chloride (PVC) pipes industry are growing at 16-18 per cent per annum. The demand of plastics goods is increasing from house hold use to industrial applications at an annual rate of 22 per cent. During 2000-2001, about four million tonnes of plastics or polymer were consumed in India. The consumption of plastics is more than 8 million tonnes in the country. The polymer production capacity has reached more than 3.5 million tonnes and increase in capacities and liberalization of trade of polymer products will lead to increase in per capita consumption i.e > 10 kg per capita. More than one-fourth of the consumption of plastics in India today is that of PVC – a chemical which is being phased out in some countries. The data reveal the following:

1. Nearly 45-60 per cent of all plastics waste is brought back to use by recycling virgin Plastics based goods.
2. From discarded computer chip boards to polythene bags all go through repeated “down cycling”.
3. Polypropylene (PP) and high-density polyethylene (HDPE) are two polymers that are recycled the most.
4. Almost 45 per cent of the total plastic consumed in the country gets converted to plastics waste.
5. About 45 per cent of this gets recycled. Thus, about 20 per cent of the annual polymer consumption or about 800,000 tonnes of plastics being recycled.

As recycling is done repeatedly, the volume of recycled plastic in the market keeps increasing. It, therefore, becomes a large enough chunk for the virgin plastic manufacturers to worry about competition. The manufacturers often mention the recyclers as important agencies managing the plastics wastes. The recyclers in India also import a lot of plastics waste to regurgitate back into the markets. Import of plastics waste under licence is allowed, however a substantial amount do come to

the country without licence. The high powdered committee on the management of hazardous wastes set up by the Supreme Court of India in 1997 reported that 24 240 tonnes of plastics scrap was imported illegally in the year 1994-95.

Recycling Plastics Wastes:

According to some reports, plastics waste accounted for 4%-9% of the waste across different income groups of the Indian Society. Nearly all plastic wastes are sold to kabariwallahs, who form the first link in the chain of recycling plastics. Small scale recycling units getting the plastics wastes from the kabariwallahs create adverse environmental impacts due to outdated technology, poor quality of raw material, and the absence of government support. They, however, help save the scarce and valuable virgin raw material and the large stretches of land needed for the disposal of wastes and its detrimental effect on the environment and offer employment also. In plastics industry, the raw material accounts for about 70% of the total production cost. Therefore, plastic recycling can save large quantities of Petro-based virgin material. Unfortunately, plastics waste recycling continues to be a disorganized and technically backward sector.

Law prohibiting identified single use plastic items:

The issue of Plastic waste management in India is to be scientifically addressed urgently. The country generates over 25,000 metric tons of plastic waste every day, and only around 60% of it is collected and managed properly. The remaining ends up in landfills, oceans, and the environment, causing serious ecological damage. Plastics waste has a negative impact on the environment and ecology and human health as it takes years to decompose and releases toxic chemicals that pollute the soil and water. The plastics waste poses a significant threat to marine life birds, fish, and other animals. In India , policy has been framed to phase out single use plastic by 2022, due to its adverse impacts on both terrestrial and aquatic ecosystems. The Ministry of Environment, Forest and Climate Change notified the Plastic Waste Management (PWM)Amendment Rules, 2021 on 12 August 2021, which prohibits identified single use plastic items which have low utility and high littering potential by 2022. Thickness of plastic carry bags increased from 50 to 75 microns from 30th September, 2021 and to 120 microns with effect from the 31st December, 2022. So, to prevent stop littering due to light weight plastic carry bags, the thickness of plastic carry bags has been increased. This will also allow reuse of plastic carry due to increase in thickness. The plastic packaging waste, which is not covered under the phase out of identified single use plastic items, shall be collected and managed in an environmentally sustainable way through the Extended Producer Responsibility of the Producer, importer and Brand owner (PIBO). For effective implementation of Extended Producer Responsibility, the Guidelines for Extended Producer Responsibility have been given legal force through PWM Amendment Rules, 2021. As per the PWM Amendment Rules, 2021, 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.

Almost all countries are fighting with pollution due to single use plastic items which has become an important environmental challenge. As stated above, India has also taken action for mitigation of pollution caused by littered Single Use Plastics. During 4th United Nations Environment Assembly in 2019, on the initiative of India adoption of this resolution was a significant step towards addressing single-use plastic products pollution thus, sending a message to states for an urgent need for the global community to focus on this issue.

The action taken so far:

The States/UTs are taking action to strengthen the waste management infrastructure through the Swachh Bharat Mission. The following safeguard measures are being taken to implement the provisions of PWM Rules and also to restrict and stop the use of identified single use plastic items:

I. States/UTs to constitute a Special Task Force for elimination of single use plastics and effective implementation of Plastic Waste Management Rules, 2016.

II. A National Level Taskforce constituted for taking coordinated efforts to eliminate identified single use plastic items and effective implementation of PWM Rules, 2016.

III. State /UT to develop a comprehensive action plan for elimination of single use plastics and effective implementation of PWM Rules, 2016, and its implementation in a time bound manner.

IV. Directions under Section 5 of Environment (Protection) Act, 1986, issued to all States/Union Territories inter alia for setting up for institutional mechanism for strengthening enforcement of PWM Rules, 2016.

V. The Government taking all measures for awareness generation towards elimination of single use plastics and effective implementation of PWM Rules, 2016.

VI. Various programmes like Awareness Campaign of Single Use Plastic 2021, essay writing competition on the theme for spreading awareness amongst school students in the country regularly.

VII. To encourage innovation in development of alternatives to identified single use plastic items and digital solutions to plastic waste management.

VIII. The India Plastic Challenge – Hackathon 2021, organized for students of Higher Educational Institutions and start-ups recognized under Start-up India Initiative.

One such very important initiative by central Government is to involve MSME sectors in Capacity building workshops to provide them technical assistance for manufacturing of alternatives to banned single use plastic items with the involvement of regulators, along with Ministry of Small Micro and Medium Enterprises and Central Institute of Petrochemicals Engineering (CIPET) and their state centres. The main aim is to support such enterprises in transitioning away from banned

single use plastics. These are significant steps to promote innovation and provide an ecosystem for accelerated penetration and availability of alternatives in the country. Therefore, at Government regulatory and community levels, a well-defined targeted Action is needed to effectively Ban identified Single Use Plastic (SUP) Items from 1st July 2022. National and State level control rooms should be set up to control illegal manufacture, import, stocking, distribution, sale and use of banned single use plastic items. Such programmes will have success only through effective engagement and concerted actions by all stakeholders. The Public Participation is critical to banning SUPs. India had engaged in a comprehensive way with UNEA members in 2019 to develop consensus on a resolution that was adopted for taking global action on plastic pollution.

Effort by Odisha Government:

The state government has made strict provisions to ensure that no person shall sell, trade, manufacture, import, store, carry, transport, use or distribute the following within the municipal limits or as the case may be within the Municipal Corporation Limits of Bhubaneswar, Cuttack, Berhampur, Rourkela, Sambalpur and Puri, viz.,

1. Polythene carry bags of any shape, thickness and size (excluding compostable);
2. Bottled drinking water Polyethylene Terephthalate (PET/PETE) bottles of less than 500 ml. capacity;
3. Single use disposable cutleries made up of Thermocol (polystyrene) or plastic such as dish, spoon, cup, plate, glass, fork, bowl, straw, pouch to store liquid and container etc. of any size and shape, and Thermocol decorative materials (flowers and the like);

Note: Compostable plastics shall conform to the Indian Standard: IS 17088:2008. The manufacturers or seller of compostable plastic carry bags shall obtain a certificate from the Central Pollution Control Board before marketing or selling.

In the state, vendors shall be allowed to use polythene sheets not less than 50 microns thickness for storing, transporting, dispensing or packaging of any article or commodity or food items, consumables including drinking water, mineral water, packaging of milk and milk products and edible oil in sealed manner.

This excludes any plastic, polythene packaging materials used in plant nurseries, horticulture, agriculture and healthcare sector like medicines, blood transportation bags, syringe, sample or specimen bags, re-sealable bags, medical instruments and accessories etc.; In the state, no person shall knowingly or otherwise, litter any public place with any plastic item allowed under this Order. The authorities or owners of places of religious worship or institutions, hotels and restaurants and other such places like marriage or party halls, offices or institutions and the outdoor event managers located at the places mentioned in sub-Para (a) of para 1 shall be responsible for ensuring strict compliance of the aforesaid directions and they shall provide space for collection of plastic waste within their campus and returning the same to the concerned manufacturer or retailers or supplier. The manufacturers or Producers of Bottled drinking water Polyethylene Terephthalate (PET/PETE) bottles and the Milk

processing units shall take back the Polyethylene Terephthalate (PET/PETE) bottles and plastic waste respectively through the same retail sales network under mutually agreed terms and conditions based on Extended Producer's Responsibility.

Measures to Reduce Plastic Waste:

1. To address this issue, the government of India has implemented several measures to reduce plastic waste and improve plastic waste management in the country.
2. One of the most significant steps taken by the government is the implementation of the Plastic Waste Management Rules, which aim to reduce the use of single-use plastic and promote the use of alternative materials.
3. The rules require manufacturers to take responsibility for the collection and disposal of plastic waste and encourage the use of eco-friendly packaging materials.
4. Another measure taken by the government is the Swachh Bharat Abhiyan, a nationwide campaign launched in 2014 to improve cleanliness and sanitation in India.
5. As part of this campaign, the government has set up various initiatives to increase the collection and segregation of plastic waste, such as door-to-door collection, community bins, and plastic waste collection centres.

Effort by Citizens's group, Private Sector and NGOs in the Fight Against Plastic Waste:

In addition to these measures, various initiatives have been taken by non-governmental organizations (NGOs) and the private sector to address the issue of plastic waste in India. For example, some NGOs are working on awareness campaigns to educate the public about the harmful effects of plastic waste and encourage the use of reusable bags, containers, and other alternatives. The private sector is also playing a significant role in addressing plastic waste in India. Many companies are implementing eco-friendly policies and initiatives to reduce plastic waste, such as introducing biodegradable packaging materials, setting up plastic waste collection and recycling facilities, and collaborating with NGOs to promote sustainable practices. Despite the efforts being made to address plastic waste in India, there are still significant challenges that need to be overcome. One of the major challenges is the lack of infrastructure and enforcement for proper waste management. Many areas in India lack the necessary facilities and infrastructure to collect and manage plastic waste effectively, leading to a build-up of plastic pollution. However, there are also several opportunities for addressing plastic waste in India. For example, the country has a significant potential for recycling and waste-to-energy technologies, which can help reduce the amount of plastic waste and mitigate its negative impacts on the environment. All stakeholders, including individuals must take responsibility and play their part in reducing plastic waste and promoting sustainable practices. School education must have curriculum from middle school level and above on this subject to education students who will be future educators for building a better environmental discipline among society.

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* The paper has been developed form the information available in various documents of Central and State governments on Plastics management including Gazette Notifications.

BECOMING A GREEN INSTITUTION

BIODEGRADABLE MODELS AT RMNH BHUBANESWAR, ANOTHER STEP TOWARDS PLASTIC FREE GREEN INSTITUTION

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Mo EF & CC, Govt. of India

Introduction & Background

Through 2018 onwards India as a leading nation has stressed in detail to raise awareness among the people about plastic, problems lead by usage of plastic and the threat posed on the environment by plastic from manufacturing to its disposal with a focused theme "Beat Plastic Pollution". Regional Museum of Natural History Bhubaneswar (RMNH BBSR) conducted a 10 days summer vacation programme for young school students on this theme. During the program, intense discussion between participants and Museum authorities were on. Though participants being teenage students only, pointed out serious issues in government and private institutions. Participant pointed out a few questions that are fundamentally hard to answer i.e.

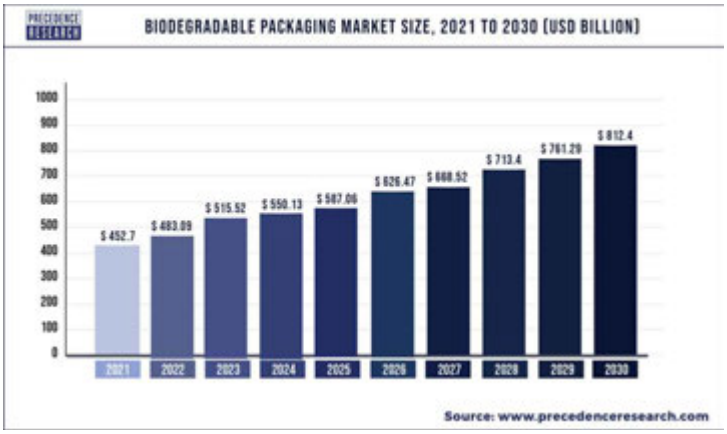
a. If plastic is so bad for the environment why is it not simply all types banned from manufacturing?

b. Why can't the fund be used on finding alternative resources which are spent on massive awareness programs?

c. Who actually holds the responsibility of plastic pollution and if no one, then why this hue and cry?

d. If the museum and similar institutions are still using plastic fibre and non-biodegradable material to make educational exhibits about the preservation of the environment then how can they teach us not to play with the plastic anymore?

The author, then, working as Scientist C/HO and In-charge of the museum, realised that merely conducting awareness programmes may not be fruitful but a model has to be presented to induce institutional behavioural change. It had to be a model/method which may not serve the complete solution to the plastic pollution problem but at least encourages everyone to opt for a better choice according to the feasibility and availability of the recyclable material in the respective institution. It is noteworthy to mention that Biodegradable, fibrous (Paper Corrugated Paper & Board, Plywood etc.) waste mostly in educational institutions is discarded like others which ends up in the garbage pits in the outskirts of the city to rot up and produce harmful gases or sometimes to be burned to produce smoke etc. Only estimated 20% of the waste is recovered and reused in India of which educational institutes have a reserved share.



Due to lack of indigenous collection there has been a significant rise in the import bill of the paper over the years. In 1980, the import of waste paper was US$5.1 million which rose to US$ 1 billion in 2011. Today India imports around 4.0 million tonnes of waste paper every year. This import can be reduced at part by reusing the waste paper in the educational Institutions for creative purposes. A number of institutions discard dry biodegradable material in form of daily waste which mostly lands into landfills (approximately 70-75%), to the scrap dealers (5-10%) and rest to recycling plants. This discarded material has high potential of re-use into institutional resources and creatives. Amount of such available waste can be simply estimated with following graph-

Then, the team of RMNH BBSR decided to minimize use of non-eco friendly material in exhibits and models and to quit, ultimately. The team identified a number of materials inside the campus that could be used for making biodegradable models. Based on understanding and learning of the materials, the team decided to make the first pilot model of a Stingray (2x1.5x.5 ft). After a successful attempt another life sized model of King Cobra (7x2x3.5 ft) was made. Once the understanding of the material developed with the nature of armature fabrication and weight balancing, the team decided to make a larger model i.e. a baby giraffe (12x6x3 ft). Since then 6 models have been made and few of them have been successfully displayed as a permanent or temporary exhibition in the museum galleries and outdoors at various occasions. Other life sized models are Komodo Dragon (7x4x3 ft), African Silverback Gorilla (6.5x6x2.5 ft), Rock Python (5x1 ft) etc.

Concept and planning

As a standing mandate the Museum has to display more and more real specimens and less models. When made, models usually are used as duplicates to the specimens that are not easily available in the region hence it was decided to make models of those animals of which skeletons and skins are not available in India easily, both the indigenous and exotic. During making it was realized that the science for every model is different and cannot be followed again, repeatedly so there is no set procedure but innovation every time. Models are made only out of waste material of biodegradable nature, extensive planning and detailed development of concepts for every model is a mandate.

Preparatory studies help in deciding material depending on the size, weight and shape of the animal. Making of models begin through finding prospective answers to the imperative questions like how big or tall that model is going to be, how is weight balancing done by armature, what will be the main materials for making the armature, What will be the filling material of the body once the armature is ready, what will be the material for the final appearance and method of its application, what can be the prospective problems during the entire process, what could be the prospective solutions of all

those problems and once this model is ready how will it be moved from one location to another? Answers to these questions are always different every time.

Making an armature for every mode is the most important and crucial part. Every model has a different type of armature so that it can support the material to make rest of the fillings easy in the body. Mostly wood, plywood, or combination of plywood, iron sheets, iron bars, clay and jute are used to make the armature. Once the armature is prepared, the body of the model is filled with suitable filling material which can be waste newspaper, clay, jute, cotton or anything else biodegradable.

Material

Since Idea is very liberal and invites immense innovation hence there is no limit for diversity of material that can be used during making these models, still there are few thumb rules that are followed during selection of the material-

1. All the material has to be biodegradable are naturally recyclable
2. Should have an estimated life of at least 10 to 12 years
3. Should be pliable and strong as well
4. Less of hygroscopic nature

Based on the above thumb rules there are three categories in which these models can be segregated

a. **Armature:** Armature is the most important part of any model which holds all the weight and makemodel study for long. It is more like a skeleton for any model. Materials used for armature in these models are mostly waste iron bars, iron angle, wood batons, plywood, bamboo sticks etc.

b. **Body:** There are specific materials required to fill the armature so that the main shape of the animal or specimen can be achieved. Materials used for making the main body are paper, paper mache, paper tapes, jute, cloth, cotton, coconut fibre, wood chippings, clay etc.

c. **Surface:** Once the main body of the model is prepared there is always a requirement of specific material that can be used to finish the surface of the model that may be skin or fur or scales. Material used on the main surface are cloth, jute, cotton, paper mache, coconut fibres, wood dust, paper cuttings, paper scales etc. In case of specific requirements tools and assemble items are prepared to apply on the surface

Process

Process of model making is uniform for all models which involves following major steps-.

1. Preparatory discussions on Concept, Facts, Measurement, Design, Material Prospective Challenges & their Solutions and mobility of heavy models.
2. Making of armature
3. Body stuffing over the armature
4. Application of paper mache over body stuffing
5. Moisture minimization by sun drying
6. Smoothing and texture improvement by sanding, scrapping and scaling
7. Application of protection coat
8. Colouring, Skin preparation and finishing

Technical issues and solutions

Difficulties during development of any model can be categorised into following main areas-

A. Base/Platform related

During fabrication sometimes it is realized that the base of the model is not adequately designed to bear the entire weight of the model and in that case the base needs to be changed which is a difficult process because the armature has already been fixed with the base. In such cases the model may need to be unfolded entirely or any alternative method is used.

B. Armature related

Unwise decisions for selection of material to make the armature mostly ruins the effort and turns up the discarding or recycling of the entire model. For smaller models using iron angle and iron bar is good but for larger models use of wooden battens and lighter material is a good decision. Armature holds the maximum weight of the model hence at the end model can be very heavy and impossible to lift and move. Scope of movement while designing the nature is necessary and the insurance of the accessibility to that scope is more necessary. Armature can easily get infested by termite and wood borer beetles. Before assembly Preventive treatment of armature against termite and Beatles is necessary.

C. Body related

After the armature body holds the second largest part of the weight and during fabrication it is imperative to decide on a lighter material for filling the main body part. Loosely filled body may turn into a badly shaped model and for that material with good compressive strength is used, that is mostly old newspaper, jute or cloth but it is more necessary that fillings are tightly held with armature so that shape of the model does not change once it is finished.

D. Material composition related

All these models are made of biodegradable waste materials that have already spent some of their life in their own way since they have been manufactured or originated. Every material is different in nature, has a different origin and life so the problems arising with the materials are unique. Problems related with material can be categorised as following-

1. Insects & Pests

Decaying a degrading condition invites a number of insects and pests towards the materials used in these models. Other than that most of these models have simple or Complex forms of carbohydrates and cellulose. Initially Fevicol had been used in the pilot model but later glue made of starch (gluten extracted) was used as an eco-friendly substitute of Fevicol And further was replaced by the bio-glue.

2. Fungus/Mould and Moss

Materials with cellulose are hygroscopic in nature, get moist easily and a variety of fungus and other biological organisms are developed. Paper mache by default takes a long time to dry which is also a reason for the development of fungus and other organisms on the surface of these models during preparation. Short exposure to direct sunlight is the best treatment for developing fungus and other such problems. If not treated in time, fungus and other organisms left in the main body may later lead to extensive deterioration and collapse of the armature and final distortion of the shape.

3. Physical

Wrong proportion of paper mache with glue can accelerate or de-accelerate the rate of drying of the main surface and may result in a sloppy, lumpy shape of the model or cracks all over. Over exposure during fungal treatment by direct sunlight also accelerates the formation of cracks. Though cracks can be repaired by applying paper mache but ultimately every crack weakens the structure. Delicate parts like tail, ears, horns etc. need adequate reinforcement from inside and proper attachment with the armature or else they keep breaking repeatedly.

Durability

Since there is no data available on making such models by any organisation hence accurate estimation of the life is not possible but based on the experience of developed technique and nature of material, durability of these models may be predicted based on the following observations-

1. If kept Indoors in a micro-climatic controlled situation, models may have a life of 18 to 20 years. May need little touch up and minor restoration in a regular interval of 1-2 years after 8-9 years of fabrication.
2. Kept indoors in an open exhibit without moisture control may have a life of 8 to 10 years. May need extensive restoration after 5 years. In such conditions regular check up and treatment of termite and insect infestation is necessary.
3. Models made with this technique cannot be placed outdoors If done so they will get destroyed immediately due to weathering.

There are models that were made in 2018 and still show the resilience towards all deteriorating factors after 5 years, keeping their conditions in the view, life of such models can easily be estimated between 12-20 years.

Cost and Production timeline

Most of the models are made of waste material and involve almost no cost. Compared with models made of fibreglass and resin these models are very cost effective but involve extensive man

hours and take 15-20 times more production time than models made of synthetic material. Only expenditure which is significant is making of bio glue. Estimated cost of all models (excluding man hours) is as following

a. Stingray - 160 Rs.
b. King Cobra - 230 Rs.
c. Baby Giraffe - 1900 Rs.
d. Komodo Dragon - 980 Rs.
e. African Silverback Gorilla - 1780 Rs.

Making Process of few prominent models

Recycling/Sustainability

Models, once worn out, can be dismantled and likewise material can be separated easily. Everything can be refined and reused for making the armature or body of new models or can be composted. In certain cases there may be some part of the model which cannot be recycled hence a separate method of disposal will be required depending on the nature of material.

PLASTIC WASTE MANAGEMENT

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Most plastic is made from fossil fuels. We extract oil or gas from land and the seabed, and transport it to what's called a 'cracker'. Crackers are plants that use huge amounts of heat and pressure to break fossil fuels into molecules that become the building blocks of polymers. Plastics are polymers, long chains of atoms arranged in repeating units. Virgin plastic is new, direct resin produced using natural gas or crude oil and without any recycled materials. As the production of virgin plastic continues to rise, with landfills already overflowing with plastic waste, and our oceans gravely polluted by plastic, our planet is suffering the consequences that, if not dealt with as soon as possible, are irreversible.

India, being one of the biggest economies and consumers of plastic in the world, has more than 20,000 plastic industries producing plastic at any given time. According to the reports for year 2017-18, Central Pollution Control Board (CPCB) has estimated that India generates approximately 9.4 Million tonnes per annum plastic waste, (which amounts to 26,000 tonnes of waste per day), and out of this approximately 5.6 Million tonnes per annum plastic waste is recycled (i.e. 15,600 tonnes of waste per day) and 3.8 Million tonnes per annum plastic waste is left uncollected or littered (9,400 tonnes of waste per day), which is either landfilled or ends up polluting streams or groundwater resources. While some kinds of plastic do not decompose at all, others could take up to 450 years to break down. There is a constant increase in plastics waste generation. One of the major reasons is that 50% of plastic is discarded as waste after single use. It also adds to increase in the carbon footprint since single use plastic products increase the demand for virgin plastic.

As plastic products have varied applications, they've become an integral part of everyday life. Naturally, after their brief use, they're discarded as wastes. Plastic wastes, unlike metal wastes, are of very low value, low density. That is why plastic wastes are landfilled, littered, burnt, etc causing environmental hazards. From 1992, China had imported very huge quantity of plastic wastes, from so many other countries, especially from western countries. Now that has been already stopped. It may be one of the reasons why the present hue and cry on plastic wastes around the world.

KNOW YOUR PLASTICS

The Society of the Plastics Industry, Inc. (SPI) introduced its resin identification coding system in 1988 at the urging of recyclers around the country. There are 7 different types of plastic polymers as given in the PIC, Plastic Identification Codes. The code number has to be printed in the plastic within a triangle of 3 chasing arrows. The purpose of the number is to identify the type of plastic

used for the product, and not all plastics are recyclable or even reusable. There are numerous plastic-based products that cannot break down and cannot be recycled.

1. PETE or PET (Polyethylene Terephthalate)

PET is one of the most commonly used plastics in consumer products, and is found in most water and soda bottles, and some food packaging. It is intended for single use applications; repeated use increases the risk of leaching and bacterial growth. PET plastic is difficult to decontaminate, and proper cleaning requires harmful chemicals. Polyethylene terephthalates may leach carcinogens. PET plastic is recyclable. The plastic is crushed and then shredded into small flakes which are then reprocessed to make new PET bottles, or spun into polyester fiber. This recycled fiber is used to make textiles such as fleece garments, carpets, stuffing for pillows and life jackets, and similar products. Products made of #1 (PET) plastic should be recycled but not reused.

2. HDPE (High-Density Polyethylene)

HDPE plastic is the stiff plastic used to make milk jugs, detergent and oil bottles, toys, and some plastic bags. HDPE is the most commonly recycled plastic and is considered one of the safest forms of plastic. It is a relatively simple and cost-effective process to recycle HDPE plastic for secondary use. HDPE plastic is very hard-wearing and does not break down

under exposure to sunlight or extremes of heating or freezing. For this reason, HDPE is used to make picnic tables, plastic lumber, waste bins, park benches, bed liners for trucks and other products which require durability and weather-resistance. Products made of HDPE are reusable and recyclable.

3. PVC (Polyvinyl Chloride)

PVC is a soft, flexible plastic used to make clear plastic food wrapping, cooking oil bottles, teething rings, children's and pets' toys, and blister packaging for myriad consumer products. It is commonly used as the sheathing material for computer cables, to make plastic pipes and parts for plumbing. Because PVC is relatively impervious to sunlight and weather, it is used to make window frames, garden hoses, arbors, raised beds and trellises. PVC is dubbed the "poison plastic" because it contains numerous toxins which it can leach throughout its entire life cycle. Almost all products using PVC require virgin material for their construction; less than 1% of PVC material is recycled. Products made using PVC plastic are not recyclable. While some PCV products can be repurposed, PVC products should not be reused for applications with food or for children's use. PVC is usually recycled into paneling, flooring, cables and decks.

4. LDPE (Low-Density Polyethylene)

LDPE is often found in shrink wraps, dry cleaner garment bags, squeezable bottles, and the type of plastic bags used to package bread. The plastic grocery bags used in most stores today are made using LDPE plastic. Some clothing and furniture also uses this type of plastic. LDPE is considered less toxic than other plastics, and relatively safe for use. It is not commonly recycled, however, although this is changing in many communities today as more plastic recycling programs gear up to handle this material. When recycled, LDPE plastic is used for plastic lumber, landscaping boards, garbage can liners and floor tiles. Products made using recycled LDPE are not as hard or rigid as those made using recycled HDPE plastic. Products made using LDPE plastic are reusable, but not always recyclable.

5. PP (Polypropylene)

Polypropylene plastic is tough and lightweight, and has excellent heat-resistance qualities. It serves as a barrier against moisture, grease and chemicals. PP is also commonly used for disposable diapers, pails, plastic bottle tops, margarine and yogurt containers, potato chip bags, straws, packing tape and rope. Polypropylene is recyclable through some curbside recycling programs. Recycled PP is used to make landscaping border stripping, battery cases, brooms, bins and trays. However, #5 plastic is today becoming more accepted by recyclers. PP is considered safe for reuse.

6. PS (Polystyrene)

Polystyrene is an inexpensive, lightweight and easily-formed plastic with a wide variety of uses. It is most often used to make disposable foam drinking cups, take-out "clamshell" food containers, egg cartons, plastic picnic cutlery, foam packaging and those ubiquitous "peanut" foam chips used to fill shipping boxes to protect the contents. Polystyrene is also widely used to make rigid foam insulation and underlay sheeting for laminate flooring used in home construction. Because polystyrene is

structurally weak and ultra-lightweight, it breaks up easily and is dispersed readily throughout the natural environment. Polystyrene may leach styrene, a possible human carcinogen, into food products (especially when heated in a microwave). Chemicals present in polystyrene have been linked with human health and reproductive system dysfunction. Recycling is not widely available for polystyrene products. Most collection centres will not accept polystyrene. While the technology for recycling polystyrene is available, the market for recycling is small. Awareness among consumers has grown, however, and polystyrene is being reused more often. Polystyrene should be avoided wherever possible.

7. Other (BPA, Polycarbonate and LEXAN)

The 7 category was designed as a catch-all for polycarbonate (PC) and "other" plastics, so reuse and recycling protocols are not standardized within this category. Of primary concern with 7 plastics, however, is the potential for chemical leaching into food or drink products packaged in polycarbonate containers made using BPA (Bisphenol A). BPA is a xenoestrogen, a known endocrine disruptor. Number 7 plastics are used to make baby bottles, sippy cups, water cooler bottles and car parts. BPA is found in polycarbonate plastic food containers often marked on the bottom with the letters "PC" by the recycling label 7. Some polycarbonate water bottles are marketed as 'non-leaching' for minimizing plastic taste or odor, however there is still a possibility that trace amounts of BPA will migrate from these containers, particularly if used to heat liquids. A new generation of compostable plastics, made from bio-based polymers like corn starch, is being developed to replace polycarbonates. These are also included in category 7, which can be confusing to the consumer. These compostable plastics have the initials "PLA" on the bottom near the recycling symbol. Some may also say "Compostable." 7 plastics are not for reuse, unless they have the PLA compostable coding. When possible it is best to avoid 7 plastics, especially for children's food. Plastics with the recycling labels 1, 2 and 4 on the bottom are safer choices and do not contain BPA. PLA coded plastics should be thrown in the compost, since PLA compostable plastics are not recyclable.

Plastic Waste Facts·

- *Every year the world uses 500 billion plastic bags.*
- *Each year, at least 8 million tonnes of plastic end up in the oceans, the equivalent of a full garbage truck every minute.*
- *In the last decade, we produced more plastic than in the whole last century.*
- *50 percent of the plastic we use is single-use or disposable.*
- *We buy 1 million plastic bottles every minute*
- *Plastic makes up 10% of all of the waste we generate.*

Recyclability of Plastic Categories

Of the 7 categories of plastics, PET bottles and HDPE are the easiest to recycle, hence leading to higher demand and more recycling of PET and HDPE products. PVC and PS on the other hand are difficult to recycle and therefore there is less collection and recycling of PVC and PS waste. Current

regulations do not take these aspects into consideration leading to dumping of plastic waste into the environment, reduced recovery and recycling.

The plastics industry has conformed to regulations by applying the required codes to consumer products, but it is up to individuals to read and understand the codes. By understanding these simple classifications, we can best use plastics to our advantage while minimizing the health and disposal issues that may otherwise arise.

EFFECTS ON HUMANS

- Due to the use of chemical additives during plastic production, plastics have potentially harmful effects that could prove to be carcinogenic or promote endocrine disruption.

  Dangerous for human lifeBurning of plastic results into formation of a class of flame retardants called as Halogens. Collectively, these harmful chemicals are known to cause the following severe health problems: cancer, endometriosis, neurological damage, endocrine disruption, birth defects and child developmental disorders, reproductive damage, immune damage, asthma, and multiple organ damage.

- Some of the additives are used as phthalate plasticizers and brominated flame retardants. Through biomonitoring, chemicals in plastics, such as BPA and phthalates, have been identified in the human population.

- Humans can be exposed to these chemicals through the nose, mouth, or skin. Although the level of exposure varies depending on age and geography, most humans experience simultaneous exposure to many of these chemicals. Average levels of daily exposure are below the levels deemed to be unsafe, but more research needs to be done on the effects of low dose exposure on humans.

- A lot is unknown on how severely humans are physically affected by these chemicals. Some of the chemicals used in plastic production can cause dermatitis upon contact with human skin. In many plastics, these toxic chemicals are only used in trace amounts, but significant testing is often required to ensure that the toxic elements are contained within the plastic by inert material or polymer.

Extended Producer Responsibility (EPR)

In addition to the responsibilities of Producer's, Plastic Waste Management Rules, 2016 defines the Extended Producer's Responsibility (EPR), as responsibility of a producer for the environmentally sound management of the product until the end of its life. Rule 9 of the Plastic Waste Management Rules, 2016 (PWMR, 2016), sets out modalities for implementation of EPR under the ambit of the rules. The producers are required to set 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.

Role of Public Institutions under Rules:

- **Waste Generators** including institutional generators, event organizers shall not litter the plastic waste, shall segregate waste and handover to authorized agency and shall pay user fee as prescribed by ULB and spot fine in case of violation.
- **Local Urban Bodies** 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. It shall be responsible for setting up, operationalisation and co-ordination of the waste management system and for performing the associated functions.
- **Gram Panchayat** either on its own or by engaging an agency shall set up, operationalize and coordinate for waste management in the rural area under their control and for performing the associated functions, namely, 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; creating awareness among all stakeholders about their responsibilities; and ensuring that open burning of plastic waste does not take place.

Action by State Govt. of Odisha

- 2004 - Ban on the use of polythene carry bags having less than 20 microns thickness.
- 2018 – Ban on the use of polythene carry bags and certain types of plastic products in the territorial jurisdiction of 5 municipal corporations w.e.f. 2nd October, 2018.
- 2019 – Ban on polythene carry bags and certain types of plastic products has imposed in all other municipal limits of the State w.e.f. 2nd October, 2019.
- Encouraged to use plastic waste in road making and as fuel for co-processing in cement kilns.

What Should We Do?

Shop Sustainably: Next time you are out shopping, choose food with no plastic packaging, carry a reusable bag, buy local products, and refill containers to reduce your plastic waste and effect on the environment.

Try a Zero-Waste Lifestyle: Become a zero-waste champion. Invest in sustainable, ocean-friendly products- reusable coffee mugs, water bottles and food wraps. Consider options like menstrual cups, bamboo toothbrushes and shampoo bars. These will help you save money and the ocean too.

Be an advocate for change: Ask your local supermarkets, restaurants and local suppliers to ditch plastic packaging, refuse plastic cutlery and straws, and tell them why. Pressure your local authorities to improve how they manage waste.

Choose plastic-free personal care products: Personal care products are a major source of microplastics, which get washed into the oceans straight from our bathrooms. Look for plastic-free face wash, day cream, makeup, deodorant, shampoo and other products.

Solution: Plastic Waste Management

Out of dry waste components in India, Plastic is the major component. Hence, Plastic waste management and recycling is the primary concern for us. Though plastic recycling in India is almost 3 times the global average, there are no comprehensive methods in place for plastic waste management. While India's per capita plastic consumption at 11 kg is much below the global average of 28 kg and just about 10% of per capita consumption in the US, by 2031, plastic waste generation in India is expected to grow by more than 3 times from current levels.

Total Plastic Waste Generated Everyday in India : 15,342 tonnes (around 60% is recycled)Out of the 60% of recycled plastic :

- 70% is recycled at registered facilities
- 20% is recycled by Unorganized Sector
- 10% of the plastic is recycled at home.

Swachh Bharat Mission (U), launched by Hon'ble Prime Minister in October 2014 laid out a well-defined roadmap for scientific waste management in the country. The circular economy agenda this Mission, rooted in the 3R (Reduce, Reuse, Recycle) principles, was a major step in this direction, where, for the first time, the issue of waste management on a Mission mode was brought to the centre of the nation's development agenda. Applying circularity principles in waste management can help India achieve its GHG emissions reduction commitments faster.

Reduce, Reuse, Recycle, and Recovery

Plastic bags are popular with consumers and retailers as they are a functional, lightweight, strong, cheap, and hygienic way to transport food and other products. Most of these go to landfill and garbage heaps after they are used, and some are recycled. Once littered, plastic bags can find their way on to our streets, parks and into our waterways. Although plastic bags make up only a small percentage of all litter, the impact of these bags is nevertheless significant. The biggest problem with plastic bags is that they do not readily break down in the environment. It has been found that, the average plastic carrier bag is used for five minutes, but takes 500 years to decompose.

- **Reduce:** First step in reducing plastic waste is to minimize single use plastics by supporting a tax on plastic bags, restraint on manufacturing of plastics, and using alternatives of plastic or biodegradable plastic.

  - For example Project REPLAN (stands for REducing PLastic in Nature) launched by Khadi and Village Industries Commission (KVIC) aims to reduce consumption of plastic bags by providing a more sustainable alternative.

- **Reuse:** Reusing plastics can reduce the demand for new plastics, hence it can act as the natural restrain on plastic manufacturing.
- **Recycle:** Plastic recycling is the process of recovering waste or scrap plastic and reprocessing it into useful products. It offers several benefits like:

  - Economic benefits due to value addition
  - Generates employment
  - Reduces depletion of fossil fuel reserves.
  - Reduces landfill problems
  - Recycling of plastics requires less energy

- **Recovery:** It is the process of converting non-recyclable plastics into a range of useful forms of energy and chemicals for industry. Since plastics contain mainly carbon and hydrogen, with similar energy content to conventional fuels such as diesel, they can be used as a potential source of fuel.

Challenges in plastic waste management

- Degradation of plastic due to recycling: Plastic deteriorates and its life span is reduced with recycling. Plastic cannot be recycled forever. Plastics are composed of repeating molecules in long chains that are bonded together at the molecular level. That is why plastics are very strong for their weight. Every time plastics are extruded, molded and recycled, some of the chains are broken and the average length of the chains decreases making the resulting plastic weaker. Mostly, plastic waste is recyclable but recycled products are more harmful to the environment as this contains additives and colors. The recycling of a virgin plastic material can be done 2-3 times only, because after every recycling, the plastic material deteriorates due to thermal pressure and its life span is reduced. Hence recycling is not a safe and permanent solution for plastic waste disposal. It has been observed that disposal of plastic waste is a serious concern due to improper collection and segregation system.

There are two primary ways to manage plastic waste.

- The first is recycling or re-processing different categories of plastic waste into secondary material.
- The second is the incineration of plastic waste. However, incineration is expensive and causes pollution if not done using the right equipment.

- Dr Rajagopalan Vasudevan, Chemistry Professor, Thiagarajar College of Engineering, Madurai, Tamilnadu, the plastic man of India, the PadmaShri award winner, on 7th May 2018, had innovated using the plastic wastes for laying of cost effective roads. Government of India had made it mandatory to use plastic wastes in its order on 2015, in laying roads. In India alone 41 lakhs KM of roads are there. Much more are on the anvil as need increases.

- Besides road making, plastic waste used for co-processing as Alternate Fuel and Raw Material (AFR) in cement Kilns and Power Plants, energy recovery or waste to oil etc. need to be

encouraged. And, in doing so, we can help our planet in more ways than one: reduce plastic waste, greenhouse gas emissions, air and water pollution, protect our planet, and save costs in the production and manufacturing of virgin plastic.

- While there are ways in which individuals can reduce their use of plastic in their daily activity, science and technology have allowed us to push the boundaries of what we once thought was impossible. The most important scientific solutions to plastic pollution that have emerged is the plastic-eating enzyme to breakdown and recycle PET Plastic, plastic-eating mushrooms that can degrade polyurethane (PU), nanotechnology that is able to break down microplastic in the water without causing any harm to marine life etc. However, collective action is imperative.

Adoption of Circular Economy

Circular economy-based development approach is one of the key strategies being adopted for achieving the 2030 Agenda for Sustainable Development Goals (SDGs). Circular economy solutions are embedded in the concept of generating zero waste through innovations that can utilize discarded materials to produce reusable and recycled products. Using Post-Consumer Recycled Plastics has numerous benefits, and once more and more corporations and brands start to realize and adopt the concept of circular economy as the model that could save and restore our planet. Rather than seeking comprehensive solutions at the downstream end, upstream material management is also critical for resource management and the circular economy, making consumer awareness and the mindset towards acceptability of recycled products equally important.

Inference

From environmental point of view, we don't need to be producing more plastic. We shouldn't be producing more plastic. Rather, we have more than enough already existing plastic that can be recycled and upcycled into new materials and new products. And, in doing so, we can help our planet in more ways than one: reduce plastic waste, greenhouse gas emissions, air and water pollution, protect our planet, and save costs in the production and manufacturing of virgin plastic. In a closed-loop, circular economy where products are designed with their end-life in mind and can continue to be recycled and regenerated into new products over and over again, our planet's resources will no longer be exploited and wasted after just a few (sometimes just one single) uses. For this to happen on a global scale, and for us to truly see a difference, it will require the efforts and willingness of everybody on the planet, on both a consumer and corporation level, because it is part of our duty and responsibility to care for our people, our planet, and our future generations.

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PLASTICS IN APICULTURE: PROSPECTS AND PROBLEMS

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Plastics are polymer based versatile synthetic or semi synthetic material used extensively in day-to- day life. Ease of availability, handling, carrying, light weight, more durability, multiple uses and many more users' friendly attributes and most strikingly being relatively inexpensive has made it very popular in every sphere. In spite of innumerable goodness when viewed vividly about the consequences of its use, it posses horror in the mind, reason being over misuse and injudicious use. Future of the use of plastic is very alarming. Though attempts have been made to produce new variant plastics from renewable materials and legal enforcement are in vogue, still intensive awareness and deep consciousness among the user can mitigate the problems associated with the issue. Besides, being used in domestic affairs, plastics are used widely in field of agriculture. This article describes briefly about the uses of plastic in apiculture, an integrated component of agriculture.

Apiculture deals with the most fascinating creature known popularly as honeybees which has been declared as the best living creatures on the earth (ICN Earthwatch Institute). It is indispensable for survival of man and animals on green globe. In ancient days people were doing honey hunting or honey gathering. They were not bothered for killing the bees, destroying their colonies and were not even aware of the enormous loss they were doing to the environment. Commercial beekeeping started during the second half of the 19th century after discovery of the concept of bee space by Father of modern beekeeping, L L Langstroth in 1851 and development of Langstroth bee hive with movable parallel hive frames. In India bees and honey were known to human being since time immemorial but honey hunting was the practice to harvest honey from natural bee colonies. Scientific beekeeping in movable hive frames in Newton hive was started in 1910 in South India by Rev. Father Newton. The purpose of beekeeping is to harvest honey hygienically and get other hive products with least damage to bees and utilize the honeybee colonies for managed bee pollination. Presently, it has been acknowledged as an alluring agro based enterprise for livelihood improvement of land less labour to commercial beekeeping by rich rural youths.

In age old practices of honey hunting or honey gathering, there was no need of the beekeeping equipments. Honey hunters were not bothered for killing the bees, destroying their colonies and were not even aware of the enormous loss they were doing to the environment. Consequent upon advent of beekeeping as a commercial avenue remarkable changes have been witnessed on growth and development of scientific beekeeping particularly with respect to beekeeping equipments used and the improved technological interventions.

Scientific beekeeping necessitates the bee equipments *viz.,* beehive with brood and super frames, hive stands, smoker, honey extractor, bee veil, nucleus hive, capturing hive, queen excluder sheet (QES), queen gate, queen cage, drone traps ,etc. Traditionally, wooden materials were preferred and used for making bee boxes, hive stands while metals are used for manufacture of smoker, honey extractor, queen excluder sheet, queen gate, queen cage etc. But plastic has made an entry to make the commercial beekeeping easier and cheaper .In abroad, plastic is used extensively in apiculture now a day to make hive, hive parts, comb foundation, comb foundation frame, flow hive etc. Even in India, plastic hive frames, QES, queen gate, queen cages and many other hive parts are available both for *Apis mellifera* and the Indian hive bee, *Apis cerana.*

Honey Bees are eusocial creatures with the highest level of social organization. They are the most fascinating, beneficial and eco- friendly insects, indispensable for human being and also behaviourally well developed, architecturally perfect and scientifically superb. Their unimaginable intelligence and amazing behaviours viz., excellent division of labour, typical comb construction style, altruism, energetic, thermoregulation, controlled fecundity, swarming, and need based absconding,

protective behaviour, interesting reproductive and foraging behaviour and unparallel communication mechanism make them unique. In nature, depending upon the species they choose their microhabitat for constructing their hive. The height from ground level, pattern of comb construction, size of comb, size and shape of comb cell vary greatly as they require very specific conditions. Honeybees have their own indefatigable action. Any foreign material or action encountered by bees takes its own time to be accepted or rejected by the bees. Thus, for successful beekeeping a thorough understanding of the choices of bees is essential to ensure acceptable interventions. Simultaneously, it is the beekeeper's discretion to judge the impact of the material or action on general behavior of honeybees and quality concern of the hive products.

Comparative analytical consideration on use of plastics in apiculture

Materials of natural selection are undoubtedly the best for the organism of concern. Living systems being dynamic and irreversible changes in organism is also inevitable, but the rate of changes depends upon the plasticity of the organism. Considering the material required for housing the honeybees, wooden material is the most preferred one as it is natural and endowed with many other favorable qualities. Ease of availability of material in abundance and cost of the material urge upon replacing the conventionally used items. Entry of plastic items in apiculture in this context is a challenge for wooden items to continue. The followings are some of the considerations of the authors solely on the issue.

1. Thermo sensitivity

Honeybees are ectotherms, but have a unique thermoregulation mechanism. They have the specific ability to control their body temperature to match environmental changes and can maintain thermal homeostasis in a colony through endothermic activity. Nevertheless like most of the organisms, schedule work performance of honeybees also depend greatly on temperature, the optimum temperature for colony build up, comb construction, brood rearing within a narrow thermal range of 33-36^{0}C .Temperature variation influence honey bees to behave differently. The effect of temperature on honey bee activities is as follows

- 33-36^{0}C - Most favorable for colony build up, comb construction, brood rearing
- 33-34^{0}C - Fav. For queen to lay eggs.
- > 34^{0}C - Try to reduce and control hive inner temperature through fanning ,
- > 33^{0}C - Some bee seal the entrance being congregated to reduce hive temperature.
- < 27 ^{0}C - Cover the entire brood frame to keep the brood frame warm.
- 20^{0}C - New queen stop nuptial flight for mating.
- 16^{0}C - Drone fails to move around the box.
- 14^{0}C - Workers remain in group for sustain low temperature.
- 10^{0}C - Workers cannot fly.
- < 8^{0}C - Lethal to the honey bees.

Beekeeping is practiced in temperate to sub tropical and tropical regions where in snow fall to heavy rain is experienced and bee boxes are stationed in open places. Since honeybees require very

specific conditions for them to stay in a beehive but the detail consequences under varied conditions needs to be analyzed by the beekeeper himself prior to adoption of the modern amenities and their effect on and hive products. Basically, the material must not conduct heat away from or into the hive. Wood being a bad conductor of heat is very suitable in this context. Besides, it prevent condensation of water, absorb moisture to mitigate dampness inside hive and can be made waterproof from outside by suitable painting to withstand rain water is regarded as the best and utilized since beginning of scientific beekeeping . Moreover, it is the choicest material of the bees as it is natural. With modernization and entry of plastic in the life processes of human being has left with a choice among the beekeepers to utilize plastic beehives for beekeeping. It has been attempted and well demonstrated along with uses of many beehive parts that are today available in plastic. Plastic hive, when manufactured care should be taken to address all the above issues, but it can no way fulfill the basic consideration of organic beekeepers who want nothing to do with synthetic materials. Cemented hives have also been tried but not found suitable.

2. Adherence to specification with scope for space manipulation

Initially, huge experimental attempts were made to develop bee boxes for hiving the honeybees for beekeeping, but the attempts were in vain. After discovery of the concept of bee space by the American apiarist, Rev.Lorenzo Lorraine Langstroth in 1851 and development of movable hive frames, scientific beekeeping gained momentum and could be successfully practiced. *Apis mellifera* is reared in Langstroth bee hive while our Indian hive bees, *Apis cerana* were kept initially in Newton hive and now hived in ISI "A" or "B" type hives. Beekeeping equipment is manufactured based on scientific specifications. It is possible to rear and maintain strong colonies if bee boxes and more specifically, the movable hive frames are constructed adhering to the specifications. For long term use of the bee boxes and its parts change of shape should be avoided and attempts should be made for retention of specification.

Expansion or reduction of hive space is another important consideration to make the beekeeping activity profiteering. In practice; at times it is required to manipulate size of bee boxes to hold more or less number of movable hive frames than the normal for higher productivity which is location specific. It is at the discretion of the beekeeper to create conditions for bees to get more space for brood rearing and honey storage through appropriate changes in size of hive or number of chambers. Good management practices warrant for need base use of multiple super or brood chambers. Manipulating hive size keeping the bee space and movable hive frame specification intact is possible and easier when it is constructed from wood. Beehive constructed from plastic normally come moulded into definite shape to reduce the manufacturing cost. Location specific size change is not possible and again change in shape during course of use will force to discard the whole plastic beehive which is not repairable economically. Further, the individual hive frames, if bends or become deformed can be repaired or replaced easily if made from wood rather than the plastic one.

3. Shelf life

Beekeeping is taken as an avocation by many beekeepers as it is a low cost enterprise and started with one time investment. Reasonably long shelf life of beekeeping equipments especially a

complete beehive is a need to make the enterprise more lucrative. Further, the beehive is kept in open place all along and exposed to varied climatic conditions. The material used to make beehive therefore is very important. It is experienced that, when bee boxes are made from standard wood, its longevity lasts for more than 15 years and with little care it get extended to 20-25 years. With little more investment and good quality teak wood, durability of bee boxes extend enormously. Plastics being non degradable pose threat to our ecosystem and thus are likely to be more durable. There are plastics which are exceptionally more durable when handled properly. But retention of shape after getting exposed to varied environmental conditions, uses of chemicals etc and more importantly acceptance by the bees for old plastic hive is skeptical.

4. Hygiene and safety

Honeybees are attacked commonly by about two dozen enemies comprising insects, mites, spiders, lizards, birds etc., and half a dozen of diseases. Many of the natural enemies harbor the bee hives while others remain off the hives. Conceptually, the material used for bee hive should remain clean, hygienic and prevent harbouring and completing part of their life cycle of any natural bee enemies inside the hive. In this context the hive made from plastic is better provided the moulded hive is devoid of spaces for harbouring stages of natural enemies safely. On the other hand, it is difficult to maintain hygiene of boxes where bee diseases are prevalent. Wooden hives are less reactive to chemicals used to control pest and diseases of the bees. Hive materials should not retain the residues of the chemicals used for treatment.

5. Universality

Promotion of beekeeping relies upon mass multiplication of queen bees, production of bee colonies and their distribution. Exchange and sharing of movable hive frames with different stages of bees among the bee keepers is a common management practice. Under such circumstances all the beekeepers should use bee hives made up of same materials. Since wood is the preferred material and in favour of organic apiculture, imposing use of plastic hive universal is very difficult.

6. Bee friendly

The material from which bee equipment, especially beehives will be manufactured should be bee friendly. Wood in this race always moves ahead of the plastic, besides being eco-friendly. Wooden bee hives, wooden structures are preferred by swarms to settle permanently. However, plastics boxes when manufactured in large scale become economical to compete with and replace the wooden hives. The plastic hives need to be primed with bee waxes to improve their acceptability by bees. Beginners are likely to face problems in starting beekeeping with plastic hives as it needs constant attention of the beekeeper till it settle permanently. Use of plastic foundations or complete plastic frame takes more time for bees to be accepted and again overall bee wax production from such hive gets declined.

7. Food safety

Honeybees produce many hive and non hive products in addition to the pollination service rendered by them. Among the products, honey is the prime product of interest of a beekeeper. It is

the only insect created food for man and consumed directly by the people. It should be safe and hygienic for human consumption. Barring exceptional case, natural honey is normally safe for human consumption. Safety of honey is affected when plastic comb are used for storing honey. Plastic gets degraded slowly in presence of heat and splitted compounds of carbons from plastic mix with honey to degrade its innate quality making it unsafe. Summer season is the best season for honeybees to gather nectar and other sweet substances and convert them to honey in their honey stomach and store in honeycomb making it matured. Thus, honey in plastic combs is subjected to heat and also subjected to the chance of deterioration.

8. Comb honey production

Recently, the author has developed the technique of comb honey production in *Apis cerana indica* in which plastic frames are fitted to wooden super frames of ISI beehive, which are further fitted with virgin natural comb. Bees readily stored honey in such comb whereas the moulded complete plastic frames, used only for comparative study purpose, took more time for their acceptance. Use of food grade out lining plastic frame can pose least effect on food quality whereas degradation of plastic affecting food quality of honey in complete plastic frame cannot be ruled out and discouraged for use by the beekeepers through awareness programme. The choice is left to the beekeeper.

Conclusively, spectacular advancement in technology has made it possible to pave way for achieving anything human desire; still nature has its own control mechanism at certain point of time. It has been possible to manufacture much durable, low-cost plastic hives with provision for ventilation, insulation, lighter weight and amenable for easier cleaning. But their suitability in cold climate and property for condensation pose some problem. Beekeeping accessories particularly plastic foundations or entire plastic frames are also manufactured from food grade plastics which are recyclable keeping in mind the food safety and problem of plastic pollution. Flow hive with inner plastic parts is a gigantic invention in beekeeping which has made beekeeping activity easier. However, wooden beehives on the other hand have its own advantages two important features being its acceptance by bees and natural nature. Hive and beekeeping accessories may be made from good quality ,food grade plastics, but the wax combs, that acts as site for oviposition, brood rearing and honey store should be natural from food safety and safer eco friendly beekeeping. The choice is left to the beekeeper to decide based on the location where beekeeping is practiced and the socio-economic conditions.

Bee friendly wooden hives

PLASTIC POLLUTION
MOVING TOWARDS THE END

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Plastic has become an integral part of our daily lives. We begin our day using tooth brush for dental wash, mugs and buckets made of plastic for bathing. Further, as we trace back our activities throughout the day, we use plastic in the form of water bottles, combs, food packaging, milk pouches, straws, disposable cutlery, carry bags, gift wrappers, toys etc. we also use plastic in almost all the sectors viz., Agriculture, industry, road transport, telecommunication, automobile, shipping and aerospace, electric and electronic and sport etc. The wide use of plastic has resulted in a large amount of waste generated. Plastic has been so much used that plastic pollution has become one of the environmental problems that the world is facing today. It has impacted the environment, our health and well-being. We have all contributed to this problem, and now it's our responsibility to work towards it to reduce and ultimately End Plastic Pollution. In this connection, the central and state government have taken various measures to stop single use plastics as it poses many challenges and threats entire mankind and environment.

The government recently announced the ban on the manufacture, sale and use of single-use plastic, effective from July 1, 2022. Under the recently notified Plastic Waste Management Amendment Rules, 2021, the ban will be implemented in a phased manner.

In the first phase, the manufacturing of plastic carry bags and commodities of less than 120 micron thickness will be banned from September 30, 2021. In the second phase, manufacturing, import, stock and sale of plastic sticks used in ear buds, plastic flags, candy sticks, ice-cream sticks, and polystyrene will be banned from January 01, 2022. In the third phase, manufacturing, import, stocking and sale of single-use plastic items such as plates, cups, glasses, cutlery, trays, wrapping and packing films around sweet boxes, invitation cards, cigarette packets, plastic PVC banners less than 100 microns will be banned from July 01, 2022.

More than 25,000 tons of plastic waste is generated every day in India. Out of the total plastic waste, around 40% is uncollected, causing severe environmental pollution. As the problem of plastic pollution is increasing in India, the government's decision is being welcomed by the industry.

Different types of Plastic ?

Plastic is an essential component of many items, including water bottles, combs, and beverage containers. Knowing the difference, as well as the SPI codes, will help you make more informed decisions about recycling. The seven types of plastic include:

- Polyethylene Terephthalate (PETE or PET)
- High-Density Polyethylene (HDPE)
- Polyvinyl Chloride (PVC)
- Low-Density Polyethylene (LDPE)
- Polypropylene (PP)
- Polystyrene or Styrofoam (PS)
- Miscellaneous plastics (includes: polycarbonate, polylactide, acrylic, acrylonitrile butadiene, styrene, fiberglass, and nylon)

When it comes to promotional giveaways, and even items we use around the house, there is no material more important than plastic. The same can be said for the items we use at the office. Most of our supplies contain at least a little bit of this material. In fact, humans have thus far produced 9.1 billion tons of plastic ! For the sake of the environment, it's important to know the different plastic types and their uses, as well as the resin identification codes found on each. This will help you make informed decisions when it comes to recycling

Sector-wise use and application of Plastic

1. Plastic in Agriculture

- Use of plastics in agriculture is termed as plasticulture. It is used for increasing yield of different crops as it growth of weeds and maintain soil moisture and reduce the cost of cultivation. It also helps to protect the crops from frost if we raise in poly houses. Most often used are PVC, PE & EVA. Use of plasticulture in horticulture & floriculture helps to mitigate the sometime extreme fluctuations in weather.

2. Irrigation System

Sprinkler:

- In this system *PVC* and *HDPE* materials are largely used due to their strength, toughness & good resistance to moisture.

Drip Irrigation:

- It allows a grower, ability to apply water and put chemicals & fertilizers directly to the plant. *PVC* and *HDPE* materials meets all the requirements of micro-irrigation.

3. Packaging & Storage of Food grains

- **Food grains is stored & protected until it can be marketed.**
- PE resalable bags & cartons, PP bags, PVC shrink packing serve the above purpose.

4. Plastic in packaging

Primary function of packaging is to protect the quality of goods.

Plastics help make packaging more efficient thereby conserving resources.

a) Food Packaging

- PET's ability to contain CO_2 makes it ideal for use in soft drinks bottle. Also, it is used for the manufacture of food containers.
- PVC film can breathe just the right amount of air & provides excellent clarity, puncture resistance and cling. So, ideal for packing fresh meat.
- PS used for the manufacture of egg cartons.

b) Pharmaceutical Packaging

- Pharmaceutical packaging products are made up of closures, bottles/vials, blister packaging and a miscellaneous category.
- Market is led by PP, PVC & HDPE.

c) Multilayer Film, Laminates and Tetra Pack

- A film for packaging food may consist of three layers imparting, respectively high strength, low oxygen permeability, and heat sealability. On same lines, *tetra pack* is gaining more and more popularity.

d) Textile Packaging

- The clarity and flexibility of low density polyethylene (LDPE) have steared it to dominated the textile packaging sector.

e) Packaging of Consumer

Durables

- HDPE & PP are major contributors for the packing of consumer durables such as cosmetic, shampoo, dish and laundry detergent, etc.

f) Bottles and containers

- PET due to its unique properties, in the last few years, has been in the development of blown bottles for consumer use, with early emphasis on the different bottle size.

g) Chemical Packaging

- Because HDPE has good chemical resistance and high tensile strength it is used for packing chemicals

h) Packaging of Electronic Goods

Components

- Expanded polystyrene (i.e. thermocol) is used for packaging and protecting electric & electronic appliances, and other sensitive products.

5. Plastic in Electrical &Electronic Engineering

- Electrical & electronics goods require properties such as temperature resistance, strength, dimensional stability & chemical resistance.
- Materials such as Nylons, ABS, PES, PEEK, etc. satisfy the above need

6. Plastic in household application

- Plastics due to its high strength-to- weight ratio, functionality and design freedom replace non-plastic materials used in household applications.

7. Plastic in Automobiles

- Plastics have influenced the automotive industry greatly by offering materials to improve interior design, comfort and safety of the passenger, low noise level and sleek exterior.

a) Two Wheelers

- Parts like Seating system, Seat Cover, Mud Guard, Head Lamp, Mask and body panels are all made from plastics, which contribute to sleek design, glossy painted surface and robust performance on the rough Indian road.

b) Three wheelers and Light Commercial Vehicles

- PP key applications include: Bumper systems, Electrical Components, Engine/Mechanical Components, Interior Trim Panels, etc.
- PVC key applications are: Wiring Harness, Spray-on Sound Deadener, Window Encapsulation, Floor Insulator, Steering Wheel, Exterior Trim, Upholstery.
- Fiber reinforced polymer (FRP) composite materials provide the automotive industry with a new range of performance attributes and processing routes.

c) Heavy Duty Vehicles

Heavy-duty vehicles head lamp housings are currently compression molded from thermo set polyester resin.

8. Plastic in shipping and aerospace

- Sea or air, plastics offer innovative materials with special property combinations or new system solutions.
- Composite constructed of steel & polyurethane, meets all these requirements. Also, repairs & installation time are considerably shorter.
- Plastic piping systems weigh one fifth less than metal-a savings of several tones per ship.
- Lightweight construction & fire protection are of prime importance in aircraft construction.
- Use of melamine resin foam in aircraft seats reduces the weight by up to 60% compared to conventional design

9. Plastic in medical, dental and pharmacy

- In health care industry, products need to be of purest quality with respect to hygiene & sterility.
- PE, PU, PET, TPE are used extensively in this field.
- Dentists are using acrylics as bone cement and as dentures.

10. Plastic in civil engineering & architecture

Drainage System

- Plastic pipes are used by contractors: based on cost, ease of installation and availability.
- Commonly plastic drainage pipes are made with PVC and HDPE.

Rain Water Harvesting

- Rainwater harvesting is a technology used for collecting and storing rainwater from rooftops, the land surface or rock catchments using simple techniques such as jars and pots as well as more complex techniques such as underground check dams.
- Rain collection barrels are made up of HDPE and piping involved in this system is met by PVC

11. Building and Civil construction

- Construction is the second largest market after packaging.
- Plastics make a significant contribution to long-life applications such as pipes, insulation, windows, cables and floor coverings.
- Plastics are used very effectively for various structural and non-structural applications in construction, because they provide long-lasting and easy solutions.

12. Roads, Pavements & Geo-membranes

- Plastics are commonly used to mark cross marks (pedestrian crossing), stop lanes & traffic guidance such as turn lanes, HOV (High Occupancy Vehicle) lanes, train crossings, taxi lanes & bus lanes.
- Dowel bars fabricated from G-FRP, as load transfer devices in highway pavement slabs is considered as solution to the corrosion problems related to the current use of steel dowels.
- Common geomembrane materials- HDPE, PVC, etc.

13. Geotechnical Engineering Sector

- The field of geotechnical engineering encompasses many aspects including: designing foundations for all types of projects, building earth-filled dams, evacuating & tunneling, & minimizing damage from natural disasters such as earth quakes, floods & landslides.
- Geotechnical engineering makes extensive use of high-tech materials, such as fancy plastics, in most modern applications. Plastics are the most important contributors towards this field.

14. Plastics in telecommunication

- There is a revolution in telecommunications due to a technology that uses plastic threads (or fibers) to transmit data, which is called as *fiber optic cable*.
- It consists of a bundle of plastic threads, each of which is capable of transmitting messages modulated light waves.
- Without plastics, there would be no cell phones

15. Plastics in Textiles

- In textiles & films, the ultrasonic process is versatile - you can seam, cut, slit, trim, tack, emboss, or cut and seal simultaneously.
- Materials suitable for ultrasonic processing include 100% synthetics such as nylon, polyester, polypropylene, some polyethylenes, modified acrylics, some vinyls, urethane, films coated paper, and synthetic blends with up to 35-50% non- synthetic fiber content.
- Materials may be woven, nonwoven, knitted, or laminated.
- It is simple and efficient, with no needles, threads, or other consumables.

16. Plastics in Instrumentation

Today's design challenge is to build increasingly complex & robust instruments or products faster, & at a lower overall production cost. Viable solutions can be found with the use of plastics. Performance plastics like polyamides, polycarbonate, etc., weigh less than metal, and some replacement parts can be less expensive to produce.

17. Plastics in sports

- Whichever sport it is-*it has played a major role in its development, athletic performance & safety.*
- Safety is very important for everyone who participates in sports.
- Players were protective pads-shoulder and chest pads, shin guards, gloves, throat protectors and padded shorts. High-density polyethylene (HDPE), which is rigid and strong, is ideal for protection equipment.
- Helmets are made of plastics, as are the boots of the ice skates.
- Plastics satisfies all the requirements, weather it is hard, glossy & scratch- resistant surface on skin, a UV-resistant coating on surfboards or a soft cushioning sports shoe sole made of PU, no other material adapts as well to the ever-growing challenges posed by sports.

Moving Towards The End Plastic of Pollution

Though plastic meet our daily needs but due its adverse effect on living creatures and environment, we should think alternatives. The government has banned on single use plastic as discussed earlier. While the ban on plastic is vital, it is also equally important to explore alternatives to replace plastic. In this context, let us look at some of the best single use plastic alternatives.

1. Bio-plastic

Bio plastics are bio degradable products that are manufactured from renewable sources. Bio plastics have similar functionalities of conventional plastic and can be used as an alternative to plastic. These are the biodegradable alternatives to plastic. These find applications across industries including packaging, textiles, automotive, agriculture, construction, paints, electrical and electronics, etc. Bio plastic products help to reduce minimize environmental pollution and improve sustainability. However, the awareness among the masses about the applications and advantages of bio plastics is less. Under the category of bioplastics, hemp, coconut coir, banana leaves are some of the materials used in the place of plastic.

2. Sugarcane Bagasse

Bagasse is the residue leftover after crushing the sugarcane. It is compostable, sustainable and eco-friendly. Therefore, it can be used in the packing of food products and making food containers. It can also be used to make disposable plates, cups, etc. It is a cost-effective and easily available alternative to plastic.

3. Paper

Paper is one of the most widely used products as an alternative to plastic for various packaging purposes. Paper is completely organic and biodegradable which causes no environmental pollution. However, unlike plastic, paper is not suitable for the packaging of certain perishable products. **Paper packaging** is one of the most profitable business ideas for small entrepreneurs with limited investment. **Paper packaging** is also concerned with deforestation which causes global warming.

4. Stainless Steel

Stainless steel is fast becoming the most used product in the place of plastic. It is manufactured from scrap metal with no impact on the environment while manufacturing. It is completely recyclable and resistant to water and air, unlike paper. It can be used to make food containers, water bottles, tiffin boxes, and various other containers in the place of plastic.

5. Glass

Glass is another best available option to replace plastic. Glass can be recycled multiple times without any change in its quality. Glass can be used to make containers to store liquid and solid products. Glass is made from sand, limestone and soda ash. Like stainless steel, it is also resistant to moisture.

Though we have alternatives but to minimize the use of plastics in daily our life and to adopt new alternatives slowly to save the environment from plastic waste. Each one of us has to learn the following **4 R's:**

1. **Refuse**: Say no to plastic, particularly single-use plastic, as much as possible.
2. **Reduce**: Limit or reduce the use of plastic in daily life.
3. **Reuse**: Reuse plastic products as much as possible before disposing of them.
4. **Recycle**: Plastic products should be recycled into other usable products. This reduces the demand for manufacturing raw plastic required to make various plastic products.

Apart from that, we should educate other people around us. We should take massive awareness campaigns in public places and help people know about plastic pollution and its harmful effects. We should stop this culture of using and throwing and start reusing things. When everyone takes a pledge to minimize the use of plastic, then we will be able to manage plastic pollution. The awareness campaign may be taken in a Public Private Partnership mode to attain remarkable success.

PLASTICS:
ADVANTAGES AND DISADVANTAGES

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Introduction to Plastics

Now-a-days, Plastics have become an inseparable and integral part of our lives. The amount of plastics consumed annually has been growing steadily. Its low density, strength, user-friendly designs, fabrication capabilities, long life, low weight and low cost are the factors behind such phenomenal growth. Plastic waste is very visible as it contributes to a large volume of the total solid wastes. Precisely because of their large visibility plastic wastes have been viewed as a serious solid waste problem.

Definition of Plastics

The word 'Plastic' is derived from the Greek Word- 'Plastikos' meaning 'fit for moulding' and also the Latin word – 'Plasticus' meaning 'capable of moulding'. The term 'plastic surgery' is called so as it derives from Greek term 'plastikos'-meaning to 'mold' or 'give form'. Plastics are defined as a range of synthetic or semi-synthetic polymeric materials that can be molded into permanent objects having the property of 'plasticity' (the ability to deform without breaking).These are also defined as a class of polymers of long carbon chains. Therefore, all plastics are polymers, but all polymers are not plastics. For ex: natural rubber (called elastomer) and wool, silk, jute etc (called natural fibers) are not plastics.

Different names of plastics World Wide

Plastic is called
- 'National flower' and 'road side daites' in South Africa
- 'National flag' in Ireland
- 'White pollution' in China

Who invented plastics?

Its inventor, the Birmingham-born artisan-cum-chemist Alexander Parkes, patented this new material in 1862 as 'Parkesine'. Considered the first man-made plastic, Parkesine (Cellulose-nitrate with camphor plasticiser), it was a cheap and colourful substitute for ivory or tortoise shell.

What is plastic made of and its types?

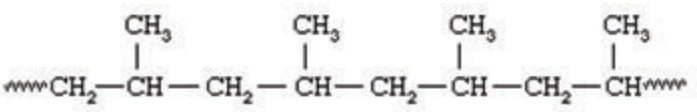
Plastics are high molecular weight organic polymers composed of various elements such as carbon, hydrogen, oxygen, nitrogen, sulphur and chlorine. They can also be produced from silicon atom (known as silicone) along with carbon; a common example is silicone breast implants or silicone

hydrogel for optical lenses. Most industrial plastics are made from petrochemicals. Moreover, Plastics are made from raw materials like natural gas, oil or plants, which are refined into ethane and propane. Ethane and propane are then treated with heat in a process called "cracking" which turns them into ethylene and propylene. These materials are combined together to create different polymers or plastics. Plastics can be divided into two major categories: thermoplastics and thermosets. Thermoplastics such as polyethylene and polystyrene are capable of being molded and remolded repeatedly. Thermosets, on the other hand, cannot be reprocessed upon reheating. During their initial processing, thermosetting resins undergo a chemical reaction that results in an infusible, insoluble network. For example, the epoxy polymer/resin.

Basically, plastics are of 6 common types such as

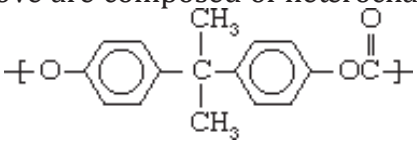
- Polyethylene Terephthalate (PET or PETE)
- High-Density Polyethylene (HDPE)
- Polyvinyl Chloride (PVC or Vinyl)
- Low-Density Polyethylene (LDPE)
- Polypropylene (PP)
- Polystyrene (PS or Styrofoam)

Plastics also can be divided into two distinct categories on the basis of their chemical composition. One category is plastics that are made up of polymers having only aliphatic (linear) carbon atoms in their backbone chains. All the commodity plastics listed above fall into this



category. The structure of polypropylene can serve as an example:

The other category of plastics is made up of heterochain polymers. These compounds contain atoms such as oxygen, nitrogen, or sulfur in their backbone chains, in addition to carbon. Most of the engineering plastics listed above are composed of heterochain polymers. An example would be



polycarbonate, whose molecules contain two aromatic (benzene) rings:

Advantages of Plastics

The growth in the use of plastic is due to its beneficial properties which include:

- Extreme versatility and ability to be tailored to meet specific technical needs.
- Lighter weight than competing materials reduces fuel consumption during transportation.
- Good safety and hygiene properties for food packaging.
- Durability and longevity
- Resistance to chemicals, water and impact.
- Excellent thermal and electrical insulation properties
- Comparatively lesser production cost
- Unique ability to combine with other materials like aluminium foil, paper, adhesives
- Far superior aesthetic appeal.
- The material of choice – Human lifestyle and plastic inseparable.
- Intelligent features, smart materials and smart systems.

Disadvantages of Plastics

Plastic contamination causes harmful contaminants that cause damage to humans, animals and plants. This can take hundreds or even thousands of years for plastic to break down, so the long-lasting environmental damage. It affects all food chain organisms from tiny species such as plankton through to whales.Toxic chemicals leach out of plastic and can be contained in almost everybody's blood and tissue. Exposure to them is related to cancer, birth defects, compromised immunity, disturbance of the endocrine and other disorders. The disposal of plastics products also contributes significantly to their environmental impact. Most plastics are non-degradable and they may take a long time to break down



once they are landfilled.

Plastic debris, laced with chemicals and often ingested by marine animals, can injure or poison wildlife. Floating plastic waste, which can survive for thousands of years in water, serves as mini transportation devices for invasive species, disrupting habitats.

Why is single-use/disposable plastic bad for the environment?

Reduce, Re-use & Recycle

Say no to plastic bags as plastic bags are threat to our environment because a single-use/disposable plastic bag takes up to 1000 years to decompose as it contains non-renewable petrochemicals. Hence plastic bags will stay for a more extended period and damage our Mother Nature. Moreover, many harmful/toxic gases are emitted during the production of polythene which causes serious problems to workers as well as to the environment. So without wasting a minute people should say no to polythene bags.

Conventional polymers or plastics such as Polyethylene (PE) and Polypropylene (PP) are present for many years after disposal. A biodegradable product has the ability to break down safely and relatively quickly by biological means, into the raw materials of nature and disappear into environment. Plastics are not biodegradable in the above way as they are long chain molecules and these chains are too tightly bonded together to be broken apart and assimilated by microbes.

Plastic bag is a “death bag.”

Plastic is a parasite that is causing the downfall for our environment. From humans to marine life, plastic has penetrated our lives and is causing severe harm. On average, every Indian uses about 1kg of plastic every month which amounts to 26,000 tonnes of plastic every day by the entire country.

Reducing the per person usage can help save not only energy but lessen the harmful effects of plastic as well. Catch Foundation has started initiative to reduce the plastic use by conducting say no to plastic campaign and specially designed Smart Bags with multiple pockets which used for various purchases like vegetables, grocery, and clothes, distributed to more than 6000 families today.

What are the main uses of plastic?

Plastic is used across almost every sector, including to produce packaging, in building and construction, in textiles, consumer products, transportation, electrical and electronics and industrial machinery.

What is the strongest plastic?

PAI – Polyamideimide (PAI) boasts the highest tensile strength of any plastic at 21,000 psi. This high performance plastic has the highest strength of any unreinforced thermoplastic, good wear and radiation resistance, inherently low flammability and smoke emission, and high thermal stability.

What is the most common type of plastic?

PET is the most widely produced plastic in the world. It is used predominantly as a fiber (known by the trade name "polyester") and for bottling or packaging. For example, PET is the plastic used for bottled water and is highly recyclable.

What can we do?

Adopt 5R'S MANTRA

- REFUSE Plastic bags, straws, cups, etc.
- REDUCE what we cannot refuse
- REUSE as many times as possible what you cannot reduce
- REPURPOSE things that are used enough. Segregate your waste and send it for
- RECYCLING and waste management.

SOLUTION TO PLASTIC POLLUTION

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1. Introduction

Plastic has become a ubiquitous part of modern life. This synthetic material now used in everything, from packaging and electronics to construction and transportation. The first synthetic plastic, Bakelite, was invented in 1907 by Belgian chemist Leo Baekeland. Subsequently, the development of new types of plastics in the following decades led to their widespread use in manufacturing and consumer goods. Plastic is durable, lightweight, and resistant to moisture and chemicals. These properties make plastic an ideal material for many products, such as packaging, medical equipment, and electronic devices. From toy to telescope, plastic has become an alternative material for everything that man needs. Even satellites and space stations have plastic components in it.

2. Plastic pollution

The convenience of plastic also led to overreliance on single-use plastic products, which have contributed to pollution due to its abundance, persistence, and harmful effects on the environment and public health. Plastic pollution has far-reaching implications for the environment and its inhabitants. The presence of plastic debris in the environment has raised serious concerns among researchers and the public due to its potential impacts on human health and the ecosystem. Chemicals found in some plastic products, such as bisphenol A (BPA) and phthalates, have been linked to health problems such as cancer, reproductive and developmental issues, and hormonal imbalances. When plastics break down in the environment it produces microplastics and toxic chemicals, eventually transferred into open surface waters or into sediments, where they can be assimilated into food chains. These microplastics may act as vectors for pathogenic organisms harmful to humans, fish, and aquaculture stocks. When microplastics are ingested, they can cause changes in gene and protein expression, inflammation, disruption of feeding behaviour, decreases in growth, changes in brain development, and reduced filtration and respiration rates. Plastics are the largest, most harmful, and most persistent fraction of marine litter, accounting for at least 85 percent of total marine waste. They cause lethal and sub-lethal effects in whales, seals, turtles, birds, and fish as well as invertebrates such as bivalves, plankton, worms, and corals through entanglement, starvation, drowning, laceration of internal tissues, smothering, and deprivation of oxygen and light, physiological stress, and toxicological harm. Plastics can also alter global carbon cycling through their effect on plankton and primary production in marine, freshwater, and terrestrial systems.

A growing number of global, regional, and national activities by governments and organizations around the world are being taken up to reduce plastic waste by introducing legislation, public awareness campaigns, and incentives for businesses to reduce their plastic use. Various technologies are being developed and implemented to reduce plastic waste and mitigate its impact on the environment. In recent years, several initiatives and innovative strategies have been taken to address the issue of plastic pollution.

2.1.Sources and Pathways of plastic pollution

Plastic pollution is a multifaceted issue and has a variety of sources and pathways. This includes plastic products used in households, industries, agriculture, microplastics, microfibers for clothing, and microbeads from personal care products, etc. One of the biggest sources of plastic pollution is the improper disposal of plastic waste. These products take hundreds of years to decompose, and when not disposed of properly, they can accumulate in landfills and litter the environment. Industrial sources, such as plastic manufacturing and production facilities, and the agencies shipping and transporting plastic products are also contributing to plastic pollution. Plastic waste can also be spread by wind and water, leading to ocean plastic pollution. The amount of plastic waste entering aquatic ecosystems could nearly triple from some 9-14 million tons per year in 2016 to a projected 23-37 million tons per year by 2040.

India is one of the world's largest contributors to plastic pollution, with an estimated 26,000 tons of plastic waste generated each day, with only 60% of it being collected and less than 10% recycled. Plastic waste has a low recycling rate as tons of plastic waste are lost to the environment, or sometimes shipped thousands of kilometres to destinations where it is generally burned or dumped. India was the world's largest importer of plastic waste, with 500,000 tons imported each year (Greenpeace India, 2019). The Indian government has responded by implementing a ban on plastic waste imports, in 2019 considering various environmental and occupational hazards for waste pickers (Ministry of Environment, Forest and Climate Change, 2019).

3. Solution for the plastics pollution

To reduce plastic pollution, a comprehensive synergistic approach is needed, including reducing plastic production and use, government regulations, fiscal instruments such as taxes, fees, and charges, improving waste management practices, and promoting recycling and upcycling, deposit-refund schemes, extended producer responsibility schemes, phasing out of unnecessary, avoidable, and problematic products and polymers, education and awareness initiatives for is also essential to change consumer attitudes and ending virgin plastic production. Some of such important aspects are discussed below.

3.1. Reduction of plastic use:

Behaviour change, product redesign, and use of alternative materials can help in decrease the amount of plastic waste generated. Pathak and Nichter (2021) described the concept of eco-

communicability, to understand how different factors are communicating about plastic control in India. They suggest that eco-communicability involves three key elements: the ability to recognize environmental problems, the ability to communicate about these problems, and the ability to take collective action to address them. They have highlighted the importance of cultural factors in shaping discourses on plastic control in India. Traditional practices, such as the use of cloth bags and metal containers for food storage, have been largely replaced by plastic in recent years. However, these practices could be revived as part of a broader effort to reduce plastic consumption in India (Pathak and Nichter, 2021). For example, switching from single-use plastic products to reusable alternatives could significantly reduce the amount of plastic waste generated. Similarly, using alternative materials such as jute, cotton, and paper bags could significantly reduce plastic waste.

Countries around the world are implementing policies to ban single-use plastics and improve waste management infrastructure. The Indian government has implemented a ban on certain single-use plastic items, such as plastic bags, straws, and cutlery, in several states and cities (Government of India, 2018). Additionally, the government has launched the Plastic Waste-Free India campaign, which aims to create awareness about the hazards of plastic waste and promote sustainable practices (Ministry of Environment, Forest and Climate Change, 2019).

3.1.1. Behavioural change:

Changing human behaviour is a critical component in addressing plastic pollution in India. The government, civil society organizations, and businesses are working to promote responsible behaviour toward plastic waste management. One of the most significant initiatives in this regard is the Swachh Bharat Abhiyan, a nationwide cleanliness campaign launched by the Indian government in 2014. The campaign aims to promote cleanliness, hygiene, and proper waste management including segregation of plastic waste across the country. Many supermarkets and stores have replaced plastic carry bags with paper bags as a market policy supporting to reduce single-use plastic with an additional charge to redirect customers to bring their own reusable bags as a method of promoting behavioural change.

In addition, various awareness campaigns and educational programs are being conducted in India to educate people about the harmful effects of plastic pollution and promote sustainable behaviour. For instance, Utter Pradesh Government's campaign 'Kabaad Se Jugaad' initiative aims to promote the recycling and reuse of waste materials, including plastics and beautify public places at low cost. Saihenjang village in Churachandpur district of Manipur in Northeast India was awarded 'Plastic Free Village on India's 72nd Republic Day on January 26, 2021. It is now a tourist attraction where people visit to learn and get inspired about waste management initiatives.

Implementing community-based solutions, such as beach clean-ups and local recycling initiatives, can help reduce plastic waste at the local level. Beach clean-up campaigns in India could significantly reduce the amount of plastic waste on beaches. Arribada or mass nesting of Olive Ridley Sea turtles is a unique event that happens on the beaches of Gahirmatha, Rusikulyaand Devi River mouth. To facilitate proper nesting Forest Department of Odisha, environmental activists like

Bichitrananda Biswal and many local volunteers also participate in clean-up drives supporting the conservation of these unique turtles and reducing plastic pollution.

In 2018, the Indian government launched a nationwide campaign called the "Swachhatahin Seva," or "Cleanliness is Service," to promote cleanliness and hygiene across the country. As part of the campaign, the government encouraged citizens to reduce their use of single-use plastics and promote waste segregation and recycling. The "Swachh Sagar, Surakshit Sagar/Clean Coast Safe Sea "campaign is a 75-day citizen-led campaign for improving ocean health through collective action. The campaign started on July 5th, 2022, and has 3 strategic underlying goals that target transformation and environmental conservation through behavior change. The three underlying goals of the campaign are to 1. Consume Responsibly 2. Segregate waste at home and 3. Dispose of Responsibly.It is the first-of-its-kind and longest-running coastal clean-up campaign in the world with highest number of people participating in it. Through this campaign, a mass behavioural change among the masses is intended by raising awareness about how plastic usage is destroying our marine life. A mobile app "Eco Mitram" has been launched to spread awareness about the campaign and for the common people to voluntary registration for the beach cleaning activity on the 17th of September 2022. The target of the program is to remove 1,500 tonnes of marine litter from the sea-coasts which will be a huge relief to marine life and the people staying in coastal areas.

The lifestyle for Environment (LiFE) movement encourages people to adopt eco-friendly practices and to become pro-planet people. LiFE movement was introduced by Prime Minister Narendra Modi at COP26 in Glasgow on 1st November 2021. By changing habits, incorporating eco-friendly practices in daily life, and working towards change in individual and community behaviour can collectively bring a change in society. Within India, at least 80 percent of all villages and urban local bodies are aimed to become environment-friendly by 2028 under Mission LiFE.

Finally, education and awareness have shown a positive impact on the public in understanding the harmful effect of plastic pollution and thereby aid in the proper disposal of plastic waste supporting their recycling.

3.1.2. Alternative materials:

In India, the use of alternative materials to plastic is gaining momentum. Alternative materials to conventional plastics are being explored as a potential solution to plastic pollution. Here are some important solutions. One such material is biodegradable bags made from plant-based polymer materials like corn starch and cellulose are already available in India and are being used in several cities. These polymers can be designed to have similar properties to traditional plastics and can be processed using existing manufacturing equipment. However, the cost of these bags is relatively higher than traditional plastic bags, which may be a barrier to their widespread adoption. Additionally, research is still needed to assess the environmental impact and sustainability of plant-based polymers. Another alternative material gaining popularity in India is paper-based packaging. The Indian company Huhtamaki PPL has developed paper-based cups and containers as an alternative to plastic products. These products are 100% recyclable and biodegradable, making them a sustainable alternative to plastic.

Another alternative material being explored in India is bamboo, which is biodegradable, renewable, and locally available. Bamboo is a sustainable material that grows quickly and can be harvested every year without damaging the environment. Several startups and organizations in India are promoting the use of bamboo as an alternative to plastic. For instance, the organization Bamboo House India has developed a range of bamboo products, including straws, cutlery, and plates, as alternatives to single-use plastics. Companies like Bambu Dru are producing bamboo-based products that are eco-friendly and biodegradable.

Bioplastics, which are made from renewable sources and are biodegradable, have the potential to reduce plastic pollution in India. The Indian government has set a target to phase out single-use plastics by 2022 and promote the use of bioplastics as an alternative (Ministry of Environment, Forest and Climate Change, 2018). Additionally, various companies in the country are investing in bioplastics production, with some startups using agricultural waste as raw material. However, the sustainability and environmental impact of bioplastics are still under debate, and further research is needed to evaluate their long-term effects.

However, some research has shown that these materials may not be a panacea for plastic pollution, as they may take several years to degrade and, as litter, can present the same risks as conventional plastics to individuals, biodiversity, and ecosystem functioning. Additionally, the production of biodegradable and compostable plastics may require more resources and energy compared to conventional plastics, leading to a potentially larger environmental footprint.

3.1.3. Product redesign:

Redesigning products that can help reduce plastic pollution include the use of sustainable materials or recycled plastics or use of less plastic than that of previously for manufacturing products. Nestle and Kellogg's redesigning their packaging to use less plastic, S'well producing reusable water bottles, and FinalStraw creating collapsible, reusable straws are some of examples.

In India, Titan Company's sustainable watches are made from recycled plastic, ITC Limited's eco-friendly notebooks, Paper Boat's paper straws, The Better India's eco-friendly products, Ecoware's natural tableware, Fabindia's sustainable clothing, and Himalayan Natural Mineral Water's biodegradable bottles are all examples of product redesigns aimed at reducing plastic pollution and promoting sustainability. Bakeys, Edible Pro, Greensole, and Bio World are some of the companies in India that produce edible cutlery made from rice, wheat, sorghum, millet, and corn flour. These companies offer a sustainable and innovative solution to the problem of plastic waste from single-use cutlery.

There is a thriving start-up scene of companies specializing in refills for products ranging from toothpaste tablets to detergents in powder form that can be made up just by adding water. Global beverage giants, Coca-Cola and PepsiCo have invested heavily in new technologies to improve drinks dispensers, encouraging consumers to use their own bottles. Starbucks uses reusable ceramic cups in-store. Two big e-commerce companies Flipkart and Amazon have committed to using paper-based materials in their packaging.

The traditional milkman has seen a renaissance in recent years – but consumers can now get a lot more than milk. DabbaDrop in London is one of many locally-based meal delivery services, with its containers inspired by the tiffin boxes of 'Dabbawallas' in Mumbai. This practice reduces generation of single use packaging waste.

4. Improved plastic waste collection

As India's cities keep expanding, so does the waste they generate. In recent years, there has been a push towards improving plastic waste collection and recycling in India. The government has launched several initiatives to promote recycling, such as the Plastic Waste Management Rules, 2016, which mandate that all manufacturers and retailers of plastic products must establish a system for collecting and recycling their products. Additionally, private companies and non-governmental organizations are joining hand in hand in setting up recycling programs, such as the Clean India Green India project by Reliance Industries, the Chintan Environmental Research and Action Group's Kabadiwala Connect program to support plastic waste management.

Kabadiwalla Connect is an interesting case study, which uses AI-powered solutions to connect people with waste collectors, waste collectors with recycling facilities, and empowering waste collectors by creating an equitable and transparent ecosystem for waste collection and disposal in their local areas. Through this initiative, Kabadiwalla Connect seeks to provide an efficient and sustainable way to collect, sort, and recycle waste, while providing an opportunity for waste collectors to earn a livelihood. These initiatives have led to an increase in the recycling of plastic waste in India. For example, the recycling rate of plastic waste in Maharashtra increased from 9% in 2015-16 to 17% in 2016-17 (Maharashtra Pollution Control Board, 2017). Similarly, the recycling rate in Delhi increased from 15% in 2015-16 to 22% in 2016-17 (Delhi Pollution Control Committee, 2017).

5. Recycling and upcycling

Recycling and upcycling are important strategies for reducing plastic waste. India has a vibrant informal sector for waste recycling, with millions of waste pickers and recyclers working in the sector. However, formal recycling infrastructure is lacking and only a small fraction of the plastic waste generated in the country is recycled.

Mechanical recycling, chemical recycling, and upcycling are among the potential to reduce plastic waste in landfills and the environment. However, the implementation of these technologies is still limited by several factors, including high costs, technological challenges, and the lack of infrastructure and regulatory frameworks. Upcycling involves using plastic waste to create new products with a higher value than the original waste. This technology offers several advantages, including the ability to reduce plastic waste, the creation of new revenue streams, and the potential to promote a circular economy. Upcycling initiatives, such as the use of plastic waste to create eco-bricks or to produce construction materials, are gaining traction in the country in recent years. However, it is still in the early stages of development.

6. Education and awareness

Education and awareness campaigns are crucial to tackling the enormous amount of plastic waste generated in India. It helps teach people about the dangers of plastic waste and the importance of recycling and reusing plastic products, as well as building a culture of responsible plastic use and disposal, thus reducing plastic pollution.

Organizations like the Centre for Environmental Education (CEE), Ahmadabad, and Saahas Zero Waste, Bangaluru work towards promoting education and awareness about plastic pollution in India. CEE conducts environmental education programs, while Saahas Zero Waste provides waste management training to communities and businesses to adopt sustainable waste management practices. Many Indian zoos including Nandankanan Zoological Park, Bhubaneswar, Museum and Zoo, Trivandrum, Nehru Zoological Park, Hyderabad are implementing deposit-refund schemes, thereby controlling plastic pollution, and spreading awareness among millions of visitors visiting those zoos.

Awareness campaigns like public service announcements, posters, and social media campaigns can promote responsible plastic use and disposal. The Swachh Bharat Abhiyan campaign initiated by the Indian government in 2014 promoted cleanliness and hygiene and created awareness of the importance of proper waste management, including plastic waste. A study in Chandigarh found that awareness campaigns can encourage individuals to switch to eco-friendly alternatives. The study showed that people who participated in an awareness campaign on the harmful effects of plastic waste were more likely to switch to eco-friendly alternatives. Therefore, there is a need to continue investing in educational programs and awareness campaigns to address the plastic pollution problem in India.

7. Innovation and technology

Innovation and technology can play a crucial role in addressing plastic pollution in India. India has several startups and companies that are developing innovative solutions to tackle plastic pollution. For instance, an Indian company Ecoware has developed biodegradable and compostable food packaging products made from plant-based materials. Another example is the Bangalore-based company EnviGreen, which has developed a range of biodegradable bags made from natural starch and vegetable oils.

India has also taken steps towards the development of innovative technologies to tackle plastic pollution. One such technology is the Plastic Waste to Fuel (PWTF) technology developed by the Indian Institute of Petroleum, which converts plastic waste into fuel. Further, bioplastics from agricultural waste could potentially replace petroleum-based plastics. The technology has been successfully demonstrated in several cities in India, including Dehradun and Chennai. Similarly, the Indian Institute of Technology (IIT) Delhi has developed a technology that converts plastic waste into tiles, paving blocks, and other construction materials. The government of India has launched a mobile app called 'Plastic Waste-Free India' to encourage citizens to recycle andsegregate plastic waste. The

app provides information on plastic waste management and connects users with local waste collectors and recyclers. Another technology developed by IIT Madras is the Plastic Liquefaction Unit, which converts plastic waste into fuel. The unit has been successfully installed and demonstrated in Chennai and has the capacity to process up to 500 kg of plastic waste per day.

There are also emerging technologies being developed to remove microplastics from the environment, such as using nanomaterials and magnetic particles to capture microplastics in water. 'Wasser 3.0' have developed a solution that is quick, efficient, and cost-effective to remove microplastic and micropollutants from different types of water. The solution uses agglomeration fixation for microplastics and chelation for inorganic compounds. 'Diwama' provides a hardware and software solution to waste-sorting facilities. The technology uses AI-based image recognition software that automates waste analysis, which can be used to optimize waste management.

Developing new technologies for collecting and removing plastic waste from the environment, including ocean clean-up technologies and river clean-up technologies. For example, a study by Lebreton et al. (2017) developed a floating device to collect plastic waste from the ocean, while a study by Mohammed et al. (2020) developed a river clean-up technology that uses drones to detect and collect plastic waste.

8. Policy and regulation:

Government regulations and international agreements have a significant impact on reducing plastic pollution in India. The most significant regulation is the Plastic Waste Management Rules (PWM) of 2016. The rules are applicable to all municipal areas in the country and impose several obligations on producers, retailers, and users of plastic. Some of the provisions include a ban on plastic bags below 50 microns, registration of manufacturers, and prohibition of plastic waste burning. In addition, India has also signed several international agreements and conventions, such as the Stockholm Convention on Persistent Organic Pollutants, which aims to eliminate or restrict the production and use of persistent organic pollutants, including certain types of plastics.

India is also a signatory to the United Nations' Sustainable Development Goals (SDGs), specifically Goal 14, which aims to conserve and sustainably use the oceans, seas, and marine resources. The country is committed to achieving the SDGs and has launched several initiatives to achieve them. For instance, the Ministry of Environment, Forest and Climate Change has launched the "Blue Flag" program, a certification program for beaches, to promote sustainable tourism and reduce marine pollution. There are 12 Blue Flag beaches in India including Puri Beach of Odisha.

In 2016, the Ministry of Environment, Forests and Climate Change (MoEFCC), Government of India issued the Plastic Waste Management Rules, which include provisions for Extended Producer Responsibility (EPR). The rules make it mandatory for plastic producers and brand owners to take back the plastic waste generated by their products and ensure its recycling and disposal. The government has implemented EPR policies for several products, including electronic waste, batteries, and packaging. The E-waste (Management) Rules require producers to collect and recycle electronic waste generated from their products.

Several Indian companies have already implemented EPR policies voluntarily. For instance, companies like Coca-Cola, PepsiCo, and Bisleri have launched initiatives to collect and recycle their plastic waste. The Confederation of Indian Industry (CII) has also launched a platform called the 'GreenCo Rating System,' which recognizes companies that have implemented sustainable practices, including EPR. However, implementation of these policies remains a challenge, and the recycling infrastructure for many products is still underdeveloped.

However, there are several key challenges in the implementation of government policies, including weak enforcement mechanisms, lack of public awareness, and inadequate waste management infrastructure. These challenges must be addressed through a multi-pronged policy framework that combines regulatory, economic, and social measures. The successful implementation of the policy framework requires the collaboration and participation of various stakeholders, including government agencies, industry, civil society organizations, and local communities. Monitoring and evaluating the effectiveness of the policies and initiatives is crucial to ensure that they achieve their intended outcomes (Raha et al, 2021).

9. Conclusion

Plastic pollution is a significant environmental problem that requires a multifaceted approach to address. Sustainable waste management practices, reduction of plastic use, circular economy strategies, biodegradable plastics, clean-up technologies, education and awareness, policy and regulation, industry responsibility, community-based solutions, and technological innovations are all potential solutions for reducing plastic pollution. By implementing a combination of these solutions, it is possible to reduce the amount of plastic waste in the environment and protect our ecosystems and human health.

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ROLE OF ALGAE FOR **MITIGATING PLASTIC POLLUTION**

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The "white pollution" caused by plastic debris affects both sea life and human beings as microplastics can enter the food chain and cause several health impacts. Plastic recycling, chemical treatments, incineration and landfill are apparently not the optimum solutions for reducing plastic pollution. Hence, this review presents two newly identified environmentally friendly approaches, plastic biodegradation and bioplastic production using algae, to solve the increased global plastic waste. Algae, particularly microalgae, can degrade the plastic materials through the toxins systems or enzymes synthesized by microalgae itself while using the plastic polymers as carbon sources. On the other hand, algae-derived bioplastics have identical properties and characteristics as petroleum-based plastics, while remarkably being biodegradable in nature.

Introduction

One of the most ubiquitous and long-lasting recent changes to the surface of the globe is the accumulation of fragmented plastics. Global production of plastics had increased to around 359 million metric tons in 2018, from 245 million metric tons in 2008, and it is expected to be tripled by the year of 2050, accounting for one fifth of global oil consumption [1]. The "white pollution" caused by plastic debris causing serious impacts on marine life and on human health since microplastics has been detected in food and air samples. With all the severe consequences, methods to help in plastic degradation and alternatives to conventional plastics have attracted the attention of researchers since the use of plastic materials are inevitable for daily life needs.

Various microorganisms have great potential to convert certain plastic polymer biologically into simpler products via aerobic and anaerobic mechanism. They synthesized enzymes with simple or multiple toxin systems involve a reduction in activation energy to weaken the chemical bonds in the polymer .On the other hand, there is an increasing demand on the environmental-friendly polymers (i.e., biodegradable plastics) in various applications such as packaging, health and agriculture industry. Nowadays, terrestrial crops such as potatoes and corn are used to derive bioplastics and this leads to competition with food supplies as well as consumption of large land areas, water and nutrients, making this kind of bioplastic production not sustainable for long term. The algal biomass has the potential to synthesize new biodegradable plastics [2].

Microalgae which grow on waste resources yield biomass with high lipid content is used for bioplastic production as it does not compete with food sources. In addition, it uptake greenhouse gas due to their rapid growth and high carbon fixing efficiency . Approaches to produce microalgal bioplastics include (1) composites produced by blending microalgal biomass with petroleum or bio-

based polymers as additives and (2) biopolymers like polyhydroxybutyrates (PHBs) and starch deposited intracellularly within microalgal cells [3].Mechanism of biodegradation is presented with identification of potential algae species followed by the discussion on how microplastics affect algae, including blending microalgae with other materials and genetic engineering for microalgae strains which produce biopolymer.

Overview of plastics

The important properties of plastic are malleable, mouldable, strong, durable, lightweight and inexpensive, making it suitable for the manufacturing of a variety of products including household items, product packaging and shopping bags, which are mostly single-use products .They are synthetic organic polymers, which are hydrophobic, inert, high-molecular-weight long chains of molecules (monomers) that joined together by covalent bonds. These conventional plastics made of heavy crude oil could lead to issues of fossil resource depletion, climate change and greenhouse gases emissions [4]. However, the biodegradability of plastics relies on their chemical structure but not on the sources used to collect the monomers . For example, commonly used plastics, polyethylene terephthalate (PET), polyvinyl chloride (PVC), high-density polyethylene (HDPE), low-density polyethylene (LDPE), polystyrene (PS), polypropylene (PP), and miscellaneous plastics are non-degradable plastics even though the starting monomers of polymers such as PE(Polyethylene), PP(Polypropylene), PVC and PET could be obtained from biological resources.

Degradable plastics can be divided into four groups: compostable plastics, photodegradable plastics, bio-based plastics and biodegradable plastics. Biodegradable plastics, which usually break down while interacting with water, enzymes, UV and gradual changes in pH, can be produced by renewable resources including components of animals, living plants and algae as well as microorganisms. An example of biodegradable plastics is polyhydroxyalkanoate (PHA) which is completely biodegradable and has similar properties as conventional plastics. This biodegradable bioplastic approach is extremely resource-efficient with the advantages of saving energy, avoiding food waste and reducing carbon dioxide emissions [5].

Plastic waste treatment

The recycling of plastics in conventional way is relatively inefficient and less cost-effective where it deteriorates the quality of the polymers yielded. Therefore, biodegradation of plastic is an alternative effective, eco-friendly and innovative method. Biodegradation refers to any chemical or physical change in material resulted from biological activity. For example, *Ideonella sakaiensis* 201-F6 was observed to consume PET as the sole carbon source. Two novel enzymes (i.e., PET hydrolase (PETase) and mono(2-hydroxyethyl) terephthalic acid hydrolase (MHETase)) were discovered to hydrolyze PET(Polyethylene terephthalate) into non-toxic monomers e.g., terephthalic acid (TPA), ethylene glycol (EG). Besides *I. sakaiensis* which naturally secretes PETase, several bacterial systems such as *Bacillus* and *Escherichia* have been tested to produce synthetic PETase . At least 27 enzymes which degrade synthetic oligomers or polymers have been identified and most of them were cutinase, lipase and esterase . In most cases, multiple enzymes and metabolic pathways must be employed for plastic degradation instead of a single enzyme [6].

Plastic biodegradation by algae

Microalgae is a potential candidate for plastic biodegradation since they do not contain endotoxins and don't require organic carbon sources. In contrast the bacterial systems which may be considered as a biological pollutant due to endotoxins and requirement of a rich carbon source for growth. Moreover, *I. sakaiensis* and other microbes used for PETase generation do not adapt well to marine habitats where the accumulation of most plastic waste occurs .Algae colonize on artificial substrata like polythene surfaces in sewage water and these were found to be less hazardous and non-toxic. Adhesion of algae on the surface will initiate the biodegradation and their production of ligninolytic and exopolysaccharide enzymes is the key for plastic biodegradation. The algal enzymes present in the liquid media interact with macromolecules present at the plastic surface and triggers the biodegradation. The polymer is utilized by algae as carbon source since the species growing on the PE surface were to found to have higher cellular contents (protein and carbohydrates) and higher specific growth rate [7].

Five methods of biodegradation including fouling, corrosion, hydrolysis and penetration, degradation of leaching components as well as pigment coloration via diffusion into the polymers were observed. Blue-green alga (Cyanobacterium), *Anabaena spiroides*, showed the highest percentage of LDPE degradation (8.18%) followed by diatom *Navicula pupula* (4.44%) and green alga *Scenedesmus dimorphus* (3.74%) [8]. Cyanobacteria (*Phormidium lucidum* and *Oscillatoria subbrevis*) are capable of colonizing the PE surface and biodegrading LDPE efficiently without any pretreatment or pro-oxidant additives. Biodegradation of bisphenol A (BPA), which is a widely used polymer in plastic industry, by using *Aeromonas hydrophilia* bacteria and *Chlorella vulgaris* . Similar results were obtained by using green alga *Chlorella fusca* var. vacuolata.[9].

Microalgae can also be genetically modified to a microbial cell factory which is capable of producing and secreting plastic degrading enzymes. For example, green microalgae *Chlamydomonas reinhardtii* was transformed to express PETase and the cell lysate of the transformant was co-incubated with PET, resulting in dents and holes on the PET film surface as well as TPA(Terephthalic acid), which is the fully degraded form of the PET. *Phormidium. tricornutum* also produce PETase which showed catalytic activity against PET and the copolymer polyethylene terephthalate glycol (PETG) [10]. These studies have provided a promising environmentally friendly solution to biologically degrade PET using microalgae via synthetic biology.

Potential of algae as a source of bioplastics

Bioplastics are defined as plastics that are made fully or partially from biomass or renewable sources, such as food crops, and have the identical function as the petroleum-based plastics . Bioplastics can be made up of different materials which have different properties. Generally, bioplastics are divided into three main groups [11]:

i. Bio-based but non-compostable plastics: PE, PP, PET, polytrimethylene terephthalate (PTT) or polyester elastomers (TPC-ET)

ii. Bio-based and degradable plastics: Polylactic acid (PLA), PHA, starch, cellulose

iii. Fossil resource-based plastics that are biodegradable: Polybutylene adipate terephthalate (PBAT)

The manufacture of bioplastics, from corn, wheat, soy proteins, milk proteins, collagen and gelatin raises the concern on the sustainability of these feedstocks, such as the competition between land and water resources for human consumption , difficulties in the extraction of polymers due to layered cell walls . In addition, the "green" plastics made from cassava, corn or sago, face the issues of poor water resistance and mechanical properties. Therefore, algae have been emerging as a novel and potential biomass source to manufacture bioplastics as they can be cultivated on non-arable lands and have short harvesting time, [12].Besides, algae do not compete with the food production for human consumption, are tolerant to harsh environmental conditions, can remediate wastewater and utilize carbon dioxide for biomass production thus alleviating the greenhouse effect. Summing up, algal-based bioplastics serve as a promising and nontoxic alternative that can reduce the use of fossil fuels, enhance plastic quality and minimize negative environmental impacts brought by the excessive use of petroleum-based plastics [13].

Microalgae-based bioplastics can be produced through a few approaches, such as direct use of microalgae biomass, blending with other materials, intermediate biorefinery processing and genetic engineering to create ideal polymer-producing microalgae strains [14]. The algal biomass comprises of protein and carbohydrate-based polymers which can be utilized as one of the bioplastics components. Currently, starch, cellulose, PHA, PHB, PLA, PE, PVC and protein-based polymers are some of the examples of the compounds from algal biomass used to develop biodegradable plastics. Among these polymers, PHA is the most recommended to produce bioplastics because it can be biodegraded by enzymatic action. On top of that, PHB, a type of PHA, recently has emerged as a new polymer to produce bioplastics due to the good barrier for oxygen. The bacteria, for instance, *Ralstonia eutropha* and *Bacillus megaterium*, are known to produce PHB as an intracellular carbon source [15].Algal starch is used as a raw material for the bioplastic, agar from algae and coated calcium carbonate that could replace petroleum-based plastics. Although the end-products are lightweight, they are waterproof, strong and durable. Moreover, the bioplastics can be composted or used as fertilizer to help maintaining soil moisture.

Colonization of algae on plastic contaminated waste water body

The green alga viz *Scenedesmus dimorphus*, *S.quadricauda Pithophora sp. Chlorella vulgaris,Stigeoclonium tenue, ,Oedogonium sp., Spirogyra sp. Coleochaete scutata, Chaetophora,* the blue-green alga viz *Anabaena spiroides*, *Oscillatoria princeps, O. acuminate, Phormidium calcicola, Calothrix marchica, C.fusca, Arthrospira platensis Lyngbya cinerascens, Nostoc carneum,N.linckia, Spirulina major, Cylindrospermum muscicola, , Microcystis aeruginosa, Closterium constatum, Chroococcus, Aphanothece, Fragilaria* and diatom *Navicula pupula,N.minuta, Nitzschia sp., N. intermedia, Amphora ovalis.*

Blending with other materials for bioplastic production

The blending materials can be obtained from algae biomass, for instance, PLA(Polylactic acid), PHA(Polyhydroxyalkanoate), cellulose, starch and protein. Moreover, polyvinyl alcohol (PVA) is

blended with starch of *Ulva armoricana* to synthesize bioplastics. The starch reduced the amount needed of PVA by approximately 40% while maintaining the cohesion. At the same time, the degradation rate of blended product was fast, which was over 80% mineralization in 100 days, showing the potential as the biodegradable and eco-compatible composite. The biomass of *Chlorella* sp. and *Spirulina* sp. is used for the synthesis of algal-based bioplastics [16].

Laminaria japonica (brown algae) and *Enteromorpha crinite* (green algae), used to synthesize seaweed reinforced PP (Polypropylene)biocomposites. They were mixed separately with latex of *Artocarpus altilis* and *Calostropis gigantea* to substitute the use of glycerol as plasticizer because the increased concentration of glycerol reduced the thickness and density of the bioplastics. *Calothrix scytonemicola* which is a PHA-rich algae, *Microcystis aeruginosa* had the highest concentration of PHB (0.49 ± 0.5 mg mL1) and can be used for producing bioplastic with the demonstrated good plasticizing capacity[17].

Challenges of algal bioplastics

Firstly, the identification of the most suitable algae to produce polymers for sustainable bioplastics with different properties is necessary and essential. The factors like biodegradability, feedstock renewability, degradation rate, brittleness, consumer acceptability, polymer size, molecular weight and moisture content of the product to be checked . Large-scale cultivation is needed to produce polymers or other compounds, such as starch. Furthermore, the waste management of bioplastics is essential.

Conclusions

The extensive exploitation of fossil fuels and the increased global disposal of non-biodegradable conventional plastics in an uncontrollable manner are urging researchers to develop efficient methods to biodegrade plastic and alternative materials to substitute plastics, in order to mitigate plastic pollution. Employing microalgae for plastic biodegradation provides several advantages compared to bacterial systems, hence it is presented as a potential solution. Bioplastics production using microalgae are inexpensive and environmentally safe to substitute conventional plastics. However, the research on the algae-based bioplastics are still in the experimental or infancy stage and infeasible to be commercialized at industrial scale, making the advancement of technology and continual R&D in bioplastics significant.

ALTERNATIVES OF PLASTIC FOR SUSTAINABLE DEVELOPMENT

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The invention of plastic and its adoption for use in our day- to- day life has made our life easier. But we have to plan for sustainable development and keep our eco-system habitable, for our younger generation. This is the primary duty of the present generation to give a better environment to the successors as a legacy. In our plastic-filled world, avoiding plastic can be pretty challenging. But finding alternatives to common items like plastic bottles and plastic packaging is becoming increasingly important. From transport to manufacturing to food services, plastic is everywhere, and combating this "white pollution" will require a sea change in the material itself.Fortunately, scientists, engineers and designers are shifting their focus to eco-friendly alternatives. Now the time has come to refuse, reduce, reuse, repurpose and then recycle the waste material for a safer environment and resource conservation.The use of plastic is not only limited in household and community level, it has its foot print everywhere. The use of plastic in agriculture is an alarming threat for sustainable production. The Sustainable Development Goals, SDG-2030 claims for a good environment and sustainable development.At this juncture, it is of paramount importance to think about the environment and sustainable development.The technology of today must not be the technical evil of tomorrow. There are different suitable alternatives of plastic, which can be promoted.

Use of Plastic in everyday life

Plastic has acquired a huge place in our everyday life. This material is in our appliances, computers, clothing, and so many. Some of the most common places we find plastic is wrapped around the things we buy every day. After all, it's an effective way to keep food and cosmetics clean and fresh. If we look around we can see that plastic has taken a very important place in our everyday life. Some of the usage of plastic are enumerated here.

- **Food packaging**. Snacks, tea and coffees come in plastic. Most cheese, meat, and yogurt is packed in plastic.
- **Milk (including soy and nut milk) cartons**. Waxed cardboard contains approximately 20% plastic and 80% paper.
- **Metal cans** are often lined with plastic.
- **Personal care products**. In addition to coming in plastic bottles and tubes, many shampoos, gels, creams, moisturiser, and make up contain synthetic polymers.

- **Dental floss and disposable razors** are also often made from plastic base materials.
- **Synthetic fabrics.** Polyester, nylon, rayon, and acrylic yarns and fabrics are all made from plastic. When washed, these materials shed millions of microscopic plastic fibres that eventually wind up in waterways. Fabrics from natural fibres like silk, cotton can be promoted. This will also help our handloom weavers to enhance their living.
- **Baby wipes and diapers.** From their inner layer to their waterproof outer cover, disposable diapers are made from plastic. Super absorbent polymer makes up the absorbent inner core, while the outer layer is usually a petroleum-based plastic or a plastic-treated fabric.
- **Feminine hygiene products.** The average disposable sanitary napkin contains plastic which can be replaced by menstrual cups which can be reused.
- **Wrapping paper** is often a mix of plant fibres and laminated plastic. Tape, glitter, and stickers also contain plastic.
- **Chewing gum.** One common ingredient included in the "gum base" is polyvinyl acetate.
- **Cigarette filters** contain cellulose acetate, a form of plastic.
- **Glues**, including school glue and wood glue, contain polyvinyl acetate, a type of plastic. The glues used to seal tea bags include polypropylene, another plastic.
- **Coffee cups.** Even those that appear to be made from paper often have plastic in the lining.

Best Alternatives to Plastic

Some of the alternatives of plastic can be used successfully for sustainability.

- **Stainless steel :** Stainless steel options for reusable food and beverage storage have been increased in recent years. One can replace single-use cups, kitchen storage, lunch boxes etc. with this durable metal.
- **Mud Container:** The mud containers are the best single use alternatives for disposable cups and glasses with polythene lining. This is eco-friendly and its promotion will certainly boost the livelihoods of the rural artisans along with sustainable environment.
- **Glass:** While not biodegradable, glass is inexpensive and infinitely recyclable. This material is brittle but can be reused if handled with care and recyclable.
- **Platinum silicone:** Made primarily of sand, food grade platinum silicone is flexible and durable. It's also heat tolerant, so you can boil, bake, and cook in these products without danger of denaturing.
- **Beeswax-coated cloth:** Used primarily as a replacement for plastic wrap and plastic bags, beeswax-coated fabric is easy to use and easy to clean.
- **Natural fibre cloth:** Natural cloth can replace plastic bags. Sustainable clothing made from organic cotton, wool, hemp, or bamboo won't shed plastic fibers when washed. Felted or recycled wool is a versatile, safe, and compostable material for children's toys, household containers etc.

- **Wood:** A renewable resource, wood from sustainably-managed forests can replace plastic in household items like cleaning brushes, kitchen utensils, and cutting boards.
- **Bamboo:** This fast-growing renewable resource can replace plastic in items like tableware and drinking straws. It is lightweight, durable, and compostable.
- **Pottery and Other Ceramics:** Pottery and other fired ceramics offer a stable, waterproof alternative that's good for food storage and tableware.
- **Paper:** Paper bags and wrappers are biodegradable and safer alternative of plastic.
- **Cardboard:** Cardboard without plastic lining is fully compostable at home.
- **BioPlastics:** Bioplastics are biodegradable or compostable plastics made from natural substances instead of petroleum.Made from a range of materials like cornstarch and sugar to mushrooms and agricultural byproducts, bioplastics are the latest attempt to prolong our disposable lifestyle.

  Scientists and manufacturers generally describe bioplastics in different ways:

1. **Non biodegradable**. These bioplastics aren't easily broken down by organisms. Like anything (even conventional plastic), they will eventually degrade after many years.
2. **Partially bio-based, "durable" plastics** that are not compostable. Microrganisms can break these down, but the process generally takes longer than 3-6 months.
3. **Biodegradable, compostable plastics** that need commercial facilities to decompose. The solution, according to plastic pollution experts, is not to continue our reliance on single-use products with different materials, but to avoid single-use products altogether.

Natural Alternative Packaging: Many companies are working on fully compostable packaging. Here are some examples already on the market.

Mushroom packaging. A combination of agricultural waste and mycelium (mushroom) root, this home compostable product is "grown" on a hemp-flour mixture, and then dried to halt the growth process. It's most commonly used to replace Styrofoam packaging.

Seaweed-based packaging that comes in edible and biodegradable grades.

Pressed hay is being used as egg cartons in Poland.

Use of plastic in agriculture and its alternatives

Modern agriculture employs a wide range of plastic products to help improve productivity. These include mulch and silage films; tunnel and greenhouse films and nets; irrigation tubes and driplines; fruit and plant protectors; non-woven protective textiles; coatings on fertilisers, pesticides and seeds; and bags, bottles, nets, ropes, lines, traps and enclosures.

- **Plastic Mulching**

  Conventional, non-biodegradable plastic mulching film inhibits weed growth, reduces evaporation from the soil, and decreases run- off due to rainfall. However, mulching film can leave large quantities of plastic in the soil.Adopting mulching practices using organic materials

or cover crops to avoid the use of plastics. Although these may appear costly, savings in inputs, long-term improvement of the soil and maintenance of yield. Shifting to biodegradable film, which would avoid the need for retrieval and end-of-life management.Increasing film strength and tear-resistance to improve retrievability from the soil after the harvest.

- **Irrigation drip tape**

  Irrigation drip tape is a thin plastic tube with apertures inserted along its length during manufacture. It is generally used in conjunction with mulching film for a single planting season and retrieved after the harvest. Drip tape improves water-use efficiency and conserves water resources by providing water directly to the plants.Some alternatives to drip tape include;Changing to an efficient and more permanent irrigation system, such as hydroponics.Increasing the strength of the tapewould reduce the risk of damage during use and retrieval, and enable it to be reused over a number of seasons.

- **Tree guards and shelters**

  Tree guards and shelters are semi-rigid tubes that are wrapped around the base of newly planted tree saplings to help them become established. They prevent damage by grazing animals, reduce competition with weeds, and create a protective microclimate. Bamboo tree guards can be used instead of plastic.

- **Plastic store bins**

  These are used to store grains and seed. These can be replaced with metal bins.

Reduce and Stop the Use of Plastic: A way forward

There are many easy ways we can all make that will help begin to cut plastic pollution. As more of us demand non-plastic options from the companies we buy from, the amount of plastic being mindlessly produced and tossed will finally begin to decline. The following procedures are to be adopted to reduce and stop the use of plastics.

- Plastic free campus campaign in educational institution will illuminate the minds of the younger generation to think about adoption of sustainable practices and products.
- Mass awareness among the mass can be created on the disadvantages of plastic and can be telecasted and broadcasted by Prasar Bharati.
- The women Self Help Groups can be engaged in creating awareness of cutting down plastic through folk songs and dance.
- Short videos on bad impact of plastic can be prepared to educate the mass.
- The locally available alternatives of plastic must be promoted by the Government
- The non- plastic zones in the rural and urban areas may be recognised and awarded for motivation of the mass.

Together we can reduce and stop the use of plastic. Say No to single use plastic.

USING RECYCLED PLASTICS TO BUILD MORE SUSTAINABLE FUTURE

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Why Recycling Plastics Is So Important

There are many reasons why recycling plastic is important. When left in landfills and other places to break down, plastic merely breaks up into tiny micro plastics. Micro plastics are invisible to the naked eye and take over every aspect of our lives. Some of the other reasons why plastic must be recycled are -

1. When we focus on recycling already existing plastics, we are curbing the need to produce newer plastics. The manufacturing of plastic can be a very invasive process. A lot of mining is required and more natural resources are used, resulting in harmful byproducts. When we recycle more, this entire chain can be broken, resulting in a positive impact to our natural resources.
2. Plastic takes many hundred years to break down completely. If we carry on with our regular plastic consumption, the majority of our landfills will only be used for plastics. This will leave very little space for other waste materials that can actually be broken down easily. This is a huge issue and recycling can help handle this issue properly on the ground level.
3. Millions of marine animals, birds and wild animals die each year due to the consumption of plastic or due to blockage of their respiratory tracts by choking and so on. This major issue can also be tackled when we take responsibility for our plastic waste and do our bit by recycling it.

Recycled plastics may have lower mechanical properties compared to virgin plastics, because each time you melt and process a plastic, the polymeric chains degrade. But these properties can be recovered by mixing it to additives or virgin plastic.

The problem is that recycling much of this plastic waste is currently unfeasible and unprofitable. Polymers such as rubbers, elastomers, and mixed plastic waste are comfortably labelled as “unrecyclable” by the recycling sector. But the amount of these materials all over the world is frighteningly large and keeps on growing. What if this plastic waste could be used to produce something useful to society?

Though alternative materials-like cotton, paper, and glass-are often depicted as more sustainable than plastic, life cycle assessments have found that plastic is the most environmentally beneficial option. For example, researchers have found that a standard plastic straw has over 60% less global

warming potential and uses 50% less energy than alternative materials during production. In the transportation sector, plastic can also be used to substitute for heavier materials.

Saving Forests with Plastic

Another major priority was curbing deforestation, which is a significant contributor to global carbon emissions. Plastic applications can substitute for tree-derived products, like timber and paper, which are major deforestation drivers. For instance, companies like EcoPost are using 100% recycled plastic to make aesthetically pleasing, high-performing "lumber" boards that can be used in a variety of construction products. Other companies like POLYWOOD save trees by building traditionally wooden furniture-like Adirondack chairs and benches-from 100% recycled plastic. Since plastic or wood-plastic composite lumber is less susceptible than traditional timber to weather, rotting, and insect damage, it's more durable over time, reducing the need for additional re-construction timber.

Substituting wood and wood-derived products with plastic has additional environmental benefits beyond lessening deforestation. It also diverts waste from landfills, keeping more plastic in the economy and promoting circularity. Additionally, considering producing pulp and paper from trees is the third-largest source of industrial air pollution, saving trees with plastic helps further emissions reduction goals as well.

Embracing Electric Vehicles

World leaders also emphasized accelerating the global transition to electric vehicles (EVs), given the sustainable benefits posed over combustion engines.

Plastic is critical for meeting increased EV market demand. For EVs to have the necessary battery range to be a realistic transportation option for consumers, they must be made from lightweight components like plastic. Already, most vehicles are about 50% volume by plastic but only 10% by weight. As EVs become more prevalent, increasing plastic applications to offset the weight of batteries and electric motors will help improve their performance and desirability for consumers.

Plastics have a role to play in developing the necessary batteries and electric motors, too. Today's EV's largely contain heavy lithium-ion batteries, increasing a car's weight by about 35%. Lightweight plastic components can replace heavier electric cell materials, like liquids or metals, improving batteries' durability and charges' longevity.

Another effective method of the use of plastic waste is Plastic Road which is a new emerging concept. The Plastic Road concept consists of a prefabricated, modular and hollow road structure made from recycled plastic. The prefabricated production, the light weight and the modular design of the Plastic Road make construction and maintenance faster, simpler and more efficient compared to traditional road structures.

Plastics are needed for human survival. Plastics are used by us from toothpaste to bed. Plastic is a valuable resource and they must be properly managed and disposed. A ban to plastic is not a solution but the method of disposal and discipline from us only will reduce the damage to environment.

PLASTIC LEACHING INTO FARMER'S FIELDS THROUGH VARIOUS USES IN AGRICULTURE

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1.0 Backdrop

Odisha is a paradox in many ways. It has abundant natural resources, paramount ecology, a large pool of technical manpower, a process thriving agro industry, fastest-growing agrarian economy but it is vulnerable to climate change and the use of plastic in agriculture. Agriculture is the primary source of livelihood for76 per cent of Odisha's population. Other natural resource-based enterprises are also the foundation for the state's economic growth. Its related sectors including field crops, vegetables, fruits, dairy, fishery and poultry are strongly associated with several United Nations Sustainable Development Goals (SDG) such as zero hunger, nutrition, and climate action among others. Agricultural growth remains the key priority of the Government of India as well as Govt. of Odisha. Over the years, Odisha agriculture has become more diversified and shifted to high-value crops, livestock, and fisheries. The high use of plastic in agriculture affects the lives and livelihoods of people. Odisha agriculture not only provides food security but also ensures the livelihood of several lakhs of the population. However, agriculture is vulnerable to existing climate variability and is further aggravated due to the impacts of climate change and pollution. More than 86% of farmers belong to marginal and small categories and the farms are a diverse, heterogeneous and unorganized farming community.

Plastics are synthetic or semi-synthetic polymers of organic molecules that have been designed to create a wide range of products with different structural and chemical properties. Plastics have become ubiquitous since their widespread introduction in the 1950s. Their properties, functionality, and relatively low cost have made them the polymers of choice for the creation of an extensive range of products, thereby helping transform food value chains, as well as massively increasing consumer choice. At present, it would be difficult to envisage living without plastics in some form or another. Agriculture broadly covers the growth and production of plants and animals for human use, either as food to feed a growing global population, or for fibres, fuels, or medicines. It includes crop and livestock production, forestry, fisheries and aquaculture.

Agricultural value chains each year use 12.5 million tonnes of plastic products. A further 37.3 million tonnes are used in food packaging. The crop production and livestock sectors were found to be the largest users, accounting for 10.2 million tonnes per year collectively, followed by fisheries and aquaculture with 2.1 million tonnes, and forestry with 0.2 million tonnes. Asia was estimated to be the largest user of plastics in agricultural production, accounting for almost half of global usage. In the absence of viable alternatives, the demand for plastic in agriculture is only set to increase. According to industry experts, for instance, global demand for greenhouse, mulching and silage films

will increase by 50 per cent, from 6.1 million tonnes in 2018 to 9.5 million tonnes in 2030. Such trends make it essential to balance the costs and benefits of plastic. Of increasing concern are microplastics, which have the potential to adversely affect human health. While there are gaps in the data, they shouldn't be used as an excuse not to act, FAO warned.

2.0 Different Uses of Plastic in Agriculture

In agriculture, plastic products greatly help productivity. Mulch films, for instance, are used to cover the soil to reduce weed growth, the need for pesticides, fertilizer and irrigation; tunnel and greenhouse films and nets protect and boost plant growth, extend cropping seasons and increase yields; coatings on fertilizers, pesticides and seeds control the rate of release of chemicals or improve germination; tree guards protect young seedlings and saplings against damage by animals and provide a microclimate that enhances growth.

Moreover, plastic products help reduce food losses and waste, and maintain their nutritional qualities throughout a myriad of value chains, thereby improving food security and reducing greenhouse gas (GHG) emissions. Modern agricultural practices employ a wide range of plastic products to help improve productivity, such as:

- **Poly mulching** – to reduce weed growth, evaporative water losses, and the need for pesticides, fertilizer and irrigation, whilst also enhancing plant growth and production.
- **Polytunnel and greenhouse films and nets** – to protect and enhance plant growth, extend cropping seasons, and increase yields.
- **Irrigation tubes and drip lines** – to optimize water use for agricultural production and productivity.
- **Poly bags and sacks** – to transport seeds and fertilizers to nurseries and fields.
- **Use of silage films** – to aid fermentation of biomass for animal fodder and avoid the need for storage buildings.
- **Plastic bottles** – to transport liquid pesticides and fertilizers to nurseries and fields.
- **Coatings on fertilizers, pesticides and seeds** – to control the rate of release of chemicals or improve germination.
- **Non-woven protective textiles or "fleece"** – to protect crops from extreme cold and/or sunlight.
- **Fruit protectors** – bags, sheaths, and nets, sometimes impregnated with pesticides to cover and protect the fruit from insect and weather damage.

Plant protectors – to protect young seedlings/ saplings against damage by animals and provide a microclimate that enhances growth (e.g. tree guards in forestry).

Use of nets, ropes, lines, traps and enclosures – to catch and farm fish and other aquatic species.

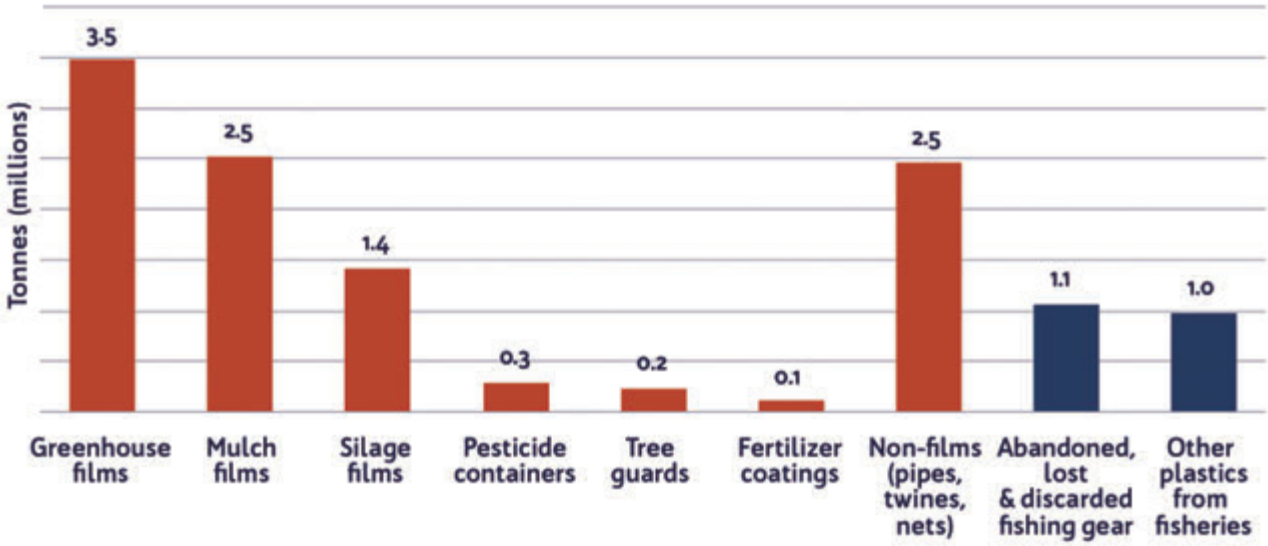


Fig-1, Annually Worldwide used Agricultural plastics

3.0 Effects of Plastic on Agriculture and Human Health

Plastics are accumulating in the world's soils at a worrying rate, according to a new report from the United Nations Environment Programme (UNEP). Microplastics can change the physical structure of the earth and limit its capacity to hold water. That can affect plants by reducing root growth and nutrient uptake. Chemical additives in plastics that leach into the soil can also impact food value chains and lead to health implications.

Soil pollution is a chemical degradation process that consumes fertile soils, with implications for global food security and human health. Soil pollution hampers the achievement of Sustainable Development Goals (SDGs), including achieving zero hunger, ending poverty, ensuring healthy lives and human well-being, halting and reversing land degradation and biodiversity loss, and making cities safe and resilient. Most contaminants originate from human activities and enter into the environment because of unsustainable production chains, consumption patterns or inappropriate waste disposal practices. Microplastics are also impacting human health when transferred to people through the food chain.

Professor Elaine Baker says" There is only a finite amount of agricultural land available," and also emphasised, "We are starting to understand that the build-up of plastic can have wide-ranging impacts on soil health, biodiversity and productivity, all of which are vital for food security,".

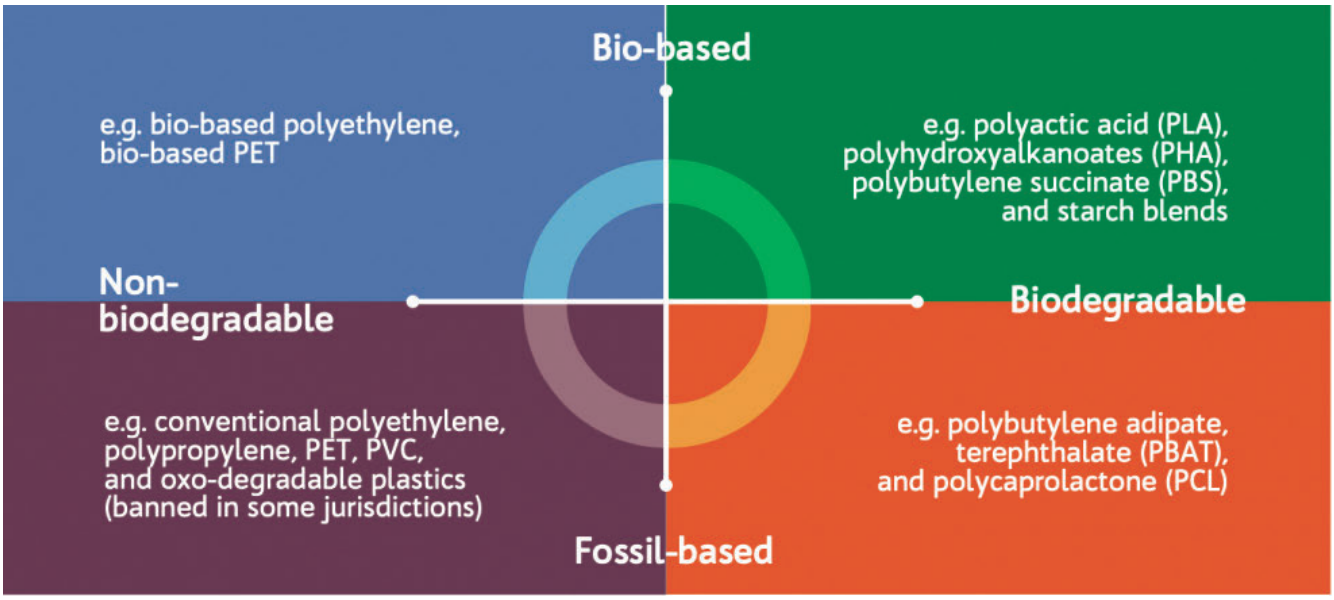
Plastics are ubiquitous in agriculture. Macroplastics are used as protective wraps around mulch and fodder. They cover greenhouses and shield crops from the elements. They are used in irrigation

tubes, sacks and bottles and intentionally added microplastics are even used as coatings on fertilizers, pesticides and seeds. But over time, macroplastics slowly break down into microplastics of shreds less than 5mm long and seep into the soil. These microplastics can change the physical structure of the earth and limit its capacity to hold water. That can affect plants by reducing root growth and nutrient uptake. Chemical additives in plastics that leach into the soil can also impact food value chains and lead to health implications.

Some countries have banned plastic microspheres, but many other microplastics continue to enter the water system. These include everything from cigarette filters to tire components to synthetic fibres from clothes. Experts say the varying size and composition of microplastics make them difficult to remove once they are in sewage. Progress is being made to improve the biodegradability of polymers used in agricultural products. Some mulch films-used to modify soil temperature, limit weed growth and prevent moisture loss-are now being marketed as fully biodegradable and compostable which is not always the case.

The diversity of polymers and additives blended into plastics makes their sorting and recycling more difficult. Being man-made, there are few microorganisms capable of degrading polymers, meaning that once in the environment, they may fragment and remain there for decades. Of the estimated 6.3 billion tonnes of plastics produced up to 2015, almost 80 per cent has not been disposed of properly. Once in the natural environment, plastics can cause harm in several ways. The effects of large plastic items on marine fauna have been well documented. However, as these plastics begin to disintegrate and degrade, their impacts begin to be exerted at the cellular level, affecting not only individual organisms but also, potentially, entire ecosystems.

Microplastics (plastics less than 5 mm in size) are thought to present specific risks to animal health, but recent studies have detected traces of microplastic particles in human faeces and placentas. There is also evidence of mother-to-foetus transmission of much smaller nano plastics in rats. While most scientific research on plastics pollution has been directed at aquatic ecosystems, especially



oceans, FAO experts found that agricultural soils are thought to receive far greater quantities of microplastics. Since 93 percent of global agricultural activities take place on land, there is an obvious need for further investigation in this area.

To reduce the reliance on hydrocarbon-based polymers, the use of bio-based polymers is expanding. But not all are biodegradable some may be as toxic as fossil fuel-based polymers and their price is still an issue. Experts say that the production of bio-based polymers should not generate land competition with food, and considerations on their growth should include those for sustainable agriculture. "None of these solutions is a magic bullet," says Baker. "Plastic is inexpensive and easy to work with, which makes trying to introduce alternatives a hard sell." The open burning of plastics releases a wide range of contaminants into the atmosphere that has potential harm to human health and the environment.

4.0 Conclusion:

The amount of plastic from agricultural sources that leak into the environment is largely unknown; however, what is becoming clear is the extent to which plastics, in general, can exert adverse effects on both ecosystems and individuals. As conventional plastics are generally resistant to biodegradation, they can persist in the environment for long periods of time and continue to cause harm long after they have reached the end of their useful lives.

The absence of viable alternatives makes it impossible for plastics to be banned. There are no silver bullets for eliminating their drawbacks. Instead, the report identifies several solutions based on the **6R model (Refuse, Redesign, Reduce, Reuse, Recycle, and Recover).** Agricultural plastic products identified as having a high potential for environmental harm that should be targeted as a matter of priority include non-biodegradable polymer-coated fertilizers and mulching films. Once in the environment, plastics can cause harm through physical effects (such as entanglement or entrapment); chemical effects (such as the release of additives or combustion products); and biological effects (such as root impediment or tissue/cellular damage). The type and severity of harm caused by plastics is generally a function of their size, with particles smaller than 5 mm called microplastics.

Most plastics are made from petroleum-derived precursors, they are associated with significant GHG emissions. Recent estimates suggest that global GHG emissions in 2019 attributed to plastics were in the region of 86 gigatonnes of carbon dioxide equivalents (CO_2-eq) (equivalent to emissions from 189 five-hundred-megawatt coal-fired power stations); a figure that is expected to rise to 1.34 Gt CO_2 eq by 2030 and 2.8 Gt CO_2 eq by 2050 should plastics consumption and use continues to increase at current rates (Hamilton et al., 2019). Assuming that plastics used in agricultural production represent 3.5 per cent of global plastic production, it can be estimated that annual GHG generation will be 47 Mt CO_2 eq by 2030 and 98 Mt CO_2 eq by 2050. Odisha manages its municipal solid waste on a day-to-day basis. The eastern state generates 1,935 tonnes of waste per day, out of which 54.2 per cent is organic waste and the rest inorganic. The success of the operation in Odisha has demonstrated that a decentralised system is the best way to manage waste, considering all aspects of environmental and economical sustainability.

SUBSTITUTES FOR UTILIZING PLASTICS IN THE FIELD OF AGRICULTURE AND ALLIED SECTORS

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Plasticulture i.e. application of plastics in agriculture cultivation is fast becoming the most sought out technique to augment farm yields and consequent farm income. In India, it can come in handy to realise the overall aim to double farm income domestically by 2022. This is more significant particularly since agriculture contributes 14% to the national economy (GDP) while more than 50% of the population is directly or indirectly dependent on it for livelihood. Moreover, the erratic nature of rainfall during the key monsoon season also exposes national income to risk. Hence, it requires mitigation measures. India supports 18% of the global population with 2.4% of land area and 4% of water resources thereby making judicious use of water even more paramount. The benefits of Plasticulture include a decline in water wastage, prevention of contamination from external agents and prevention of soil erosion.

While the use of plastics has helped farmers to produce more with less, the material presents an enormous environmental issue. But the 29th edition of UNEP's Foresight Brief explores the use of plastic in agriculture and the significant waste problem this entails which impacts on soil health, biodiversity, productivity and food security.

Plastics are used extensively in farming, from plastic coated seeds to mulch film. They also make their way into bio-solid fertilizer which is spread on fields. All these products have helped increase crop yields, but there is increasing evidence that degraded plastics are contaminating the soil and impacting biodiversity and soil health. This can lead to reduced productivity and could threaten long-term food security. As a finite resource which is under pressure, agricultural soil needs to be safeguarded from further degradation. Steps are being taken to improve the production and management of agricultural products containing plastics but there is also a need to look at a more holistic approach to food production, including nature-based solutions.

Plastics have become ubiquitous since their widespread introduction in the 1950s. Their properties, functionality, and relatively low cost have made them the polymers of choice for the manufacture of an extensive range of products, including those used in food value chains.

Modern agriculture employs a wide range of plastic products to help improve productivity. These include mulch and silage films; tunnel and greenhouse films and nets; irrigation tubes and driplines; fruit and plant protectors; non-woven protective textiles; coatings on fertilisers, pesticides and seeds; and bags, bottles, nets, ropes, lines, traps and enclosures.

Plastic products also help reduce food losses and waste, and maintain food's nutritional qualities throughout value chains, thereby improving food security and reducing greenhouse gas emissions. Hygienic plastic packaging improves food safety by reducing contamination and premature decay.

Despite these benefits, why is this an issue? Firstly, dangerous toxins released from the polyethene film can remain in the soil for centuries. Known as white pollution, polyethene residue is becoming increasingly prevalent in treated soils at levels of up to 300 kilograms (661 pounds) per hectare. Over time, this decreases soil porosity and air circulation, alters microbial communities and compromises soil fertility. Polyethene also releases carcinogenic phthalate acid esters into the soil, which together with other synthetic pesticides can be easily absorbed by the crops. This is a significant risk to human health. What's more, the polyethene films used in the coverings are low density by design, which makes the plastic extremely difficult to biodegrade. Any waste from this process is rarely accepted by recycling facilities and often ends up in landfills and oceans, wreaking havoc on ecosystems around the world.

There are two main routes whereby plastic contaminants enter agricultural systems, namely leakage from non-agricultural sources such as windblown litter, or leakage from agricultural activities when agricultural plastic products are discarded or become damaged or degraded.

As global demand for plastic increases, leakage into the environment also increases, hindering efforts to mitigate environmental contamination. Once in the natural environment, plastic can cause harm in several ways.

As larger plastics begin to disintegrate and degrade, their effects begin to be exerted at cellular level, affecting individual organisms and also, potentially, entire ecosystems. Microplastics (smaller than 5mm in size) are thought to present specific risks to animal health.

Mulching film

Conventional, non-biodegradable plastic mulching film inhibits weed growth, reduces evaporation from the soil, and decreases run- off due to rainfall. However, mulching film can leave large quantities of plastic in the soil.

A number of interventions and alternatives have been assessed in an effort to deliver similar benefits while reducing the adverse impacts of non-biodegradable mulching film.

These include the following:

- Adopting mulching practices using organic materials or cover crops to avoid the use of plastics. Although these may appear costly, savings in inputs, long-term improvement of the soil, maintenance of yields, and access to premium markets could drive change in farming practices.
- Shifting to biodegradable film, which would avoid the need for retrieval and end-of-life management.
- Increasing film strength and tear-resistance to improve retrievability from the soil after the harvest.

- In the case of certain crops, introducing reusable mulching film that can be used over many growing seasons.
- Employing product labelling. This could provide usage information to farmers and be a potential mechanism to provide traceability through the plastics and waste management supply chain.
- Implementing collection schemes linked to mandatory extended producer responsibility (EPR). This would make it easier for role players in the supply chain to adopt sound environmental management of used films.
- Launching incentives and ensuring cross-compliance to encourage environmentally responsible behaviour.
- Redesigning equipment to retrieve used films, which would reduce the amount of plastic in the soil.
- Restructuring business models. This could include changing from merely supplying the product to providing an all-encompassing service that includes supply, application, maintenance, retrieval and end-of-life management, thereby improving the effectiveness of mulching and reducing plastic leakage.

Irrigation drip tape

Irrigation drip tape is a thin plastic tube with apertures inserted along its length during manufacture. It is generally used in conjunction with mulching film for a single planting season and retrieved after the harvest. Drip tape improves water-use efficiency and conserves water resources by providing water directly to the plants. Some alternatives to drip tape include:

- Changing to an efficient and more permanent irrigation system, such as hydroponics. Increasing the strength of the tape. This would reduce the risk of damage during use and retrieval, and enable it to be reused over a number of seasons.
- Redesigning drip tape to improve its recyclability by constructing all its components from the same polymer.

Tree guards and shelters

Tree guards and shelters are semi-rigid tubes that are wrapped around the base of newly planted tree saplings to help them become established. They prevent damage by grazing animals, reduce competition with weeds, and create a protective microclimate. Damage during use and photo-degradation eventually cause the shelters and guards to fragment and possibly degrade into microplastics.

Possible alternatives include:

- Fencing areas with newly planted saplings to reduce or avoid the use of tree shelters. Redesigning the product by changing its polymer composition and thickness to increase its lifespan or promote reuse.

- Redesigning shelters to be fully biodegradable. This would mitigate the effects of plastic fragments entering the soil.
- Increasing sapling density to avoid the use of tree guards in areas where pressure from grazing animals and rodents is not excessive. This would result in more saplings perishing, but the remainder would grow to maturity.

Ear tags

Ear tags for livestock are made of hard plastic and may include an embedded radio-frequency identification device. They can be broken or lost, which may lead to animals ingesting them.

Alternatives to ear tags include:

- Adopting substitute marking systems such as injectable transponders.
- Recycling ear tags that are no longer in use.
- Introducing an incentive scheme that encourages farmers to collect broken and lost ear tags from their lands.

Greenhouse Films

Greenhouse films are highly engineered plastic products that improve yield, provide longer productive seasons, and result in lower pesticide and water usage. Designed to be used for a number of years, they eventually degrade. Alternatives include the following:

- Replacing them with durable alternatives such as silica glass. These can be more costly, however.
- Implementing mandatory EPR schemes for collecting and recycling end-of-life film. This should drive investment in improved product design, which could increase the opportunity for closed-loop material recycling.

Empty pesticide containers

Discarded pesticide containers have long been recognised as a potential hazard to public health and the environment due to the nature of their residual contents. Some alternatives and interventions include:

- Banning the use of small-dose sachets and phasing out non-recyclable packaging. Practising the triple rinse and puncturing method to improve the recyclability of empty containers.
- Introducing smart labelling and tacking to identify counterfeit pesticides and track containers through distribution channels.
- Implementing incentive schemes to encourage the return of empty containers.
- Introducing sprayer services, thus avoiding the need for each farmer to apply pesticide individually. In a community of small-scale farmers, for example, one farmer could be trained and equipped to provide a pesticide spraying service to neighbours.

SINGLE-USE PLASTIC BAN IN INDIA

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We are surrounded by plastic. Many of our furniture, clothing, electronics and food packaging are made of it. Natural materials used in products such as paper, glass, and yarn over the past decade have been replaced by plastics. Demand for low-cost plastics is growing due to urbanization and population growth. Plastic waste has been increased significantly during COVID-19 pandemic. Single-use plastic refers to plastic items that are used once and thrown on 'use and throw' principle. Single-use plastic has among the highest shares of plastic manufactured and used — from packaging of items, to bottles (shampoo, detergents, cosmetics), polythene bags, straws, face masks, coffee cups, cling film, trash bags, food packaging etc. We use about 1.2 million plastic bottles per minute in total and about 500 billion plastic cups every year. Plastic wastes release toxic chemicals into the environment and can be a serious health risk for humans and animals. Many of the most common single-use plastics polluting our environment contain toxic chemicals that harm human health. India is generating about 3.5 million tonnes of plastic waste annually and the per capita plastic waste generation has almost doubled over the last five years. If current production and plastic waste management trends continue, an estimated 12 billion tons of plastic will be in natural environment by the year 2050.

Plastic pollution can affect lands, waterways and oceans. Humans are affected by plastic pollution, such as through the disruption of the thyroid hormone axis or hormone levels. In the UK alone, more than 5 million tonnes of plastic are consumed each year, of which an estimated mere 24% makes it into recycling systems. That leaves a remaining 3.8 million tonnes of waste, destined for landfills. That is 3 trillion pieces of any sort of plastic in the oceans alone which also affects the marine base life and studies show that 90% of sea birds have some sort of plastic in them. Plastic reduction efforts have occurred in some areas in attempts to reduce plastic consumption and pollution and promote plastic recycling.

A 2017 study found that 83% of tap water samples taken around the world contained plastic pollutants. This was the first study to focus on global drinking water pollution with plastics and showed that with a contamination rate of 94%, tap water in the United States was the most polluted, followed by Lebanon and India. European countries such as the United Kingdom, Germany and France had the lowest contamination rate, though still as high as 72%. This means that people may be ingesting between 3,000 and 4,000 micro particles of plastic from tap water per year. The analysis found particles of more than 2.5 microns in size, which is 2,500 times bigger than a nanometer.


As fish is the primary source of protein for nearly one-fifth of the human population, it is important to consider that the microplastics ingested by fish can be subsequently consumed by humans at the end of the food chain. In a study done by the State University of New York, 18 fish species were sampled and all species showed some level of plastics in their systems. Many additional researchers have found evidence that these fibers had become chemically-associated with metals, polychlorinated biphenyls, and other toxic contaminants while in water. The microplastic-metal complex can then enter humans via consumption. It remains unclear how much of an impact this has directly on the health of humans, but research on this issue continues.

Plastic, because it is lightweight, is carried away by gentle winds and washed into sewers, rivers, streams and, eventually, the oceans. Up to 12.7m tonnes of plastic enters the world's oceans every year, equivalent to dumping one garbage truck of plastic per minute into the world's oceans, according to the United Nations. Sea turtles and other aquatic animals are affected by plastic pollution. Some species are consumers of jelly fish, but often mistake plastic bags for their natural prey. This plastic debris can kill the sea turtle by obstructing the oesophagus.

Over the years, plastic has emerged as one of the major reason behind the death of many cows and other animals in India. One of the biggest reasons behind it is the people who throw away food waste inside plastic bags (polythene bags). Ingestion of plastic materials may not result in immediate death, but there are several difficult symptoms seen in the victim animals. These plastics are indigestible and therefore pile up in their stomachs (rumen for cattle) with time and get entangled with different materials, forming hard cement like ball. After some time, the animal shows signs of being weak and tired then goes off feed and at times experiences bloat due to stomach blockage.

From first July 2022 single-use plastic is banned in India. The Government of India has barred the manufacturing, distribution, importing, sale, stocking and use of all single-use plastic, comprising polystyrene and expanded polystyrene commodities (from July 1) across the country. The banned items include plastic sticks(for ear buds, balloons, candies etc), plastic plates, cups, straws, knifes, spoons etc, packing/wrapping films, invitation cards, plastic banners(less than 100 microns) etc. Single-use plastic use must be avoided to curb plastic waste and pollution. We have to change our lifestyle accordingly without using single-use plastics. Instead we can use biodegradable items made up of jute, cotton, paper etc.

BANNING PLASTIC: A BIG LEAP TOWARDS A BETTER PLANET

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Our Planet, Our health: Protect the earth for next generation. In recent years the question of whether the use of plastic should be banned or not is a recurring one mostly because people have become more aware of the damage it is doing and their renewed interest in conserving the environment for future generations.It has become more crucial than ever to understand the reasons of the effects of plastic, in this should plastic be banned. We will dive into the nature of plastic, what it does to the environment and the rising debate between whether plastic should be banned or not.

Our planet is being overwhelmed by plastic population and it's not just a problem for the environment causing an imbalance in the ecosystem. Not just the faunas in land but aquatic faunas are also suffering due to the increase in number of plastic wastes per year. Alexander Parkes was the inventor of the first man made plastic. He unveiled this new material at the 1862 Great International Exhibition in London.

The per capita consumption of plastics in 2014–2015 among developed and developing countries, including India, showed that at 109 kg per capita, the USA is the largest consumer of plastic. Consumption in India was 11 kg per capita/year, whereas the global average was recorded at 28 kg. Despite its low consumption of plastic, India is the second largest producer (14.17 million tonnes (Mt)) of plastic polymers in the world. According to Makwana [86], it is estimated that every 1kg/year increase in per capita consumption will require an additional 1.25 Mt of polymers in India. In India, about 2,500,000 sets of plastic based personal protective equipment (PPE) per day have been required in the healthcare sector due to the COVID-19 pandemic . Poor consumer behavior and awareness and a lack of infrastructure for decontamination and effective reprocessing have further limited reprocessing capabilities during the COVID-19 pandemic . Plastic production and consumption in India are increasing at a very rapid pace.The western region consumed 47% of plastics in India, while the northern and southern regions consumed 23% and 21% of plastics, respectively, in 2013. Due to the growing industrial base for manufacturing and production, the consumption of various other types of plastics has increased to a great extent in recent years. In 2018–2019, consumption was 913 kilotonnes, which increased to 964 kt in 2019–2020with a year on year growth rate of 5.5%.

In todays society life without plastic is nearly impossible, we depend on it for our basic needs. It contribute to our health, safety, peace of mind and many other luxuries taken for granted even though plastic is becoming a major hazard to all of us, this issue is frequently disregarded and

underestimated. These days plastic waste is the biggest challenge of our time and its not going to disappear until we figure out how to reduce it.

In India, the PM has called a nationwide ban on single use of plasticproducts in 2018 in the occasion of World Environment Day on the theme " Beat Plastic Pollution" especially plastic bottles, cups and plastic bags. Almost 74 countries has called a ban on the use of plastic bags and 34 states impose a charge per pack. Despite the ban of plastic that weighs under 50 micron in India, a large part of our ecosystem is still under threat.

In connection with pollution and public concern about environment impact of plastics, the questions raised - "Why is Indians single-use plastic ban failing" ? and " How we can free India from Single use Plastic" ? Three months after India imposed a ban on single-use plastics to tackle plastic waste and worsening pollution, plastic are still rampant circulation across the county. The ban includes 21 Single use Plastic items such as plates, cups, cutlery, straws, packaging films and cigarette packets.Unwanted plastics that end up in the ocean deteriorate the natural ecosystem and entire marine habitat. This in turn, impedes the formation of finite natural resources and raw materials that help support the economy. All economic activities draw from the natural ecosystem for environmental services of source and sink. Availability of cheap alternatives to cater the demand of these banned products are critical challenges which need to be looked into.

Would you think life without plastic can be lived? what would our future be without plastic?

Definitely, our future without plastic will be different. Our ocean would be cleaner, there would more sea birds, more sea mammals and more fish alive in the oceans each year. Perhaps the price of our petrol would be lower, as apparently the amount of petroleum used to create 14 plastic bags is enough to drive a car one mile.

If it were not in demand for creating plastic bags, we would save a little money when we visit the local petrol pump, beaches would be cleaner, ecosystems would be healthier, animal would be safe and the government would save money on clearing rubbish and wastes from that streets if we didn't use plastic products. The positive things without plastics are infinite, what's really good is that making an impact and this isn't hard. All we need to do is we shouldaccept reusable products and refuse to take plastic products from shops.

Public Awareness towards plastic free world

Broad public awareness can help to change the way that plastic is viewed, used and managed as waste. Education and engagement can be part of a city's strategic action plan and can include consumer awareness campaigns, business awareness campaigns, documentary films, school initiatives and cleanup activities among others.

The aim is to increase public understanding and shape community perceptions on the dangers of plastic pollution and available solutions, thereby empowering more people and organizations to take action. Community actions can include changes in individual attitudes and purchasing habits,

increased sorting and recycling behaviour, responsible business processes and practices, among others.

What is Plastic free July?

Plastic Free July is a global movement and a key initiative of the Plastic Free Foundation that allows people to work towards a world free of plastic waste. Plastic Free July is a campaign led by the Plastic Free Foundation, established in 2017 as an independent non-profit organization. The month of July is celebrated annually by communities around the world and led by environmental organizations. It was started by Rebecca Prince-Ruiz (the founder of the Plastic Free Foundation) and a small team in local government in Western Australia, and is now one of the most influential environmental campaigns in the world. Millions of people across the globe take part every year with many committing to reducing plastic pollution far beyond the month of July. Plastic Free July participants reduce their household waste and recycling by 21 kilos per person per year and contribute to a total savings of 940 million kilos of plastic waste each year.

In conclusion, we have illustrated different methods that can be applied to treat plastic wastes so that the plastic life can be cyclic. The applications of these methods will save the lives of people, animals, and the environment by saving a lot of money by recycling raw-materials and reusing plastics. In addition, it is crucial to keep the environment safe this will help everyone living in this ecosystem to spend safe and healthy life. The recycling of plastic waste will help to improve the economy by decreasing the production cost. Not only economically viable, but also will help to eradicate infectious diseases that are transmitted through polluted air and water.

The ban is a significant step towards building a sustainable planet by reducing plastic waste and keep our streets clean that we can proudly hand over to the next generation. We together hand in hand can eliminate single use plastics from our daily lives. The manufacturers have to step up their game and come with advanced technology using greater manpower to create more eco-friendly alternatives and recycle most of the plastic. Shopkeepers should sell jute and clothe bags. Customers should adopt ways to reduce plastic usage. We must also put technologies in use to abolish plastic usage.

Let's understand the consequences that follow when the use of plastic is banned and by everyone's participation and combined efforts we can adopt environment friendly alternatives to built a sustainable future.

PLASTIC WASTE MANAGEMENT AND CIRCULAR ECONOMY: THE NEXUS

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Plastic is ubiquitous, it is inarguably the backbone of globalisation. They are essential to the modern age due to growth in information technology and smart packaging system. Rapid population growth, urbanization, combined with industrial growth has together led to critical waste management issues around the world. More often than once, concurrent development in economic prosperity and industrialization conflict with environmental concerns. According to US Environmental Protection Agency, since the 1960s use of plastic has grown substantially, and resultantly, the portion of plastic waste has also increased from 1% of the total municipal solid waste stream to approximately 13%. According to a report by the United Nations Environment Programme, approximately 400 million tonnes of single-use plastic (SUP) waste is generated yearly (that accounts to 47 per cent of the aggregate plastic waste) and approximately fifty per cent of this quantity is for disposal purposes, purchases that are discarded within a year.

India generates 15 million tonnes of plastic waste every year but only one-fourth of this is recycled due to lack of a functioning solid waste management system. This leads to burden on the landfills and poor socio-economic conditions of the waste pickers, mostly women.

The Plastic Waste Management market size, estimations, and forecasts are provided in terms of revenue (USD millions), considering 2023 as the base year, with history and forecast data for the period from 2017 to 2030. This report segments the global Plastic Waste Management market comprehensively. Regional market sizes, concerning products by types, by application, and by players, are also provided. The influence of COVID-19 and the Russia-Ukraine War were considered while estimating market sizes.

The 29th edition of UNEP's Foresight Brief explores the use of plastic in agriculture and the significant waste problem this entails which impacts soil health, biodiversity, productivity, and food security. Plastics are used extensively in farming, from plastic-coated seeds to mulch film.

Impact of plastic waste on agriculture:

Plastic waste can have several negative impacts on agriculture. The main impacts are as follow:

1. **Soil contamination:** Plastic waste, particularly microplastics, can contaminate the soil, making it difficult for plants to grow. These microplastics can also affect the nutrient levels in the soil, which can reduce crop yields.

2. **Water contamination:** Plastic waste can also contaminate water sources, such as rivers, lakes, and groundwater. This can lead to water pollution, which can negatively affect the growth and health of crops.
3. **Harmful effects on livestock:** Animals that ingest plastic waste, whether intentionally or unintentionally, can suffer from health issues such as digestive problems, toxicity, and even death. This can have negative effects on agriculture, as livestock is an essential part of the agricultural industry.
4. **Reduced land productivity:** Plastic waste can also lead to reduced land productivity, as it can cover the soil and prevent necessary nutrients, water, and oxygen from reaching the plants.
5. **Environmental degradation:** Plastic waste is non-biodegradable, which means it can remain in the environment for hundreds of years. This can lead to the degradation of the environment, including soil erosion, reduced biodiversity, and air pollution, all of which can negatively impact agriculture.

Recyclable plastic waste:

Recyclable plastic waste refers to plastic materials that can be processed and reused to produce new products. These types of plastics are commonly labelled with a recycling symbol and a number indicating the type of plastic resin used to make the product.

The seven plastic resin codes are as follows:

1. **Polyethylene terephthalate (PET) -** used in water bottles, soda bottles, food packaging, and more.
2. **High-density polyethylene (HDPE) -** used in milk jugs, detergent bottles, grocery bags, and more.
3. **Polyvinyl chloride (PVC) -** used in pipes, flooring, medical equipment, and more.
4. **Low-density polyethylene (LDPE) -** used in plastic wrap, grocery bags, and more.
5. **Polypropylene (PP) -** used in yogurt containers, straws, and more.
6. **Polystyrene (PS) -** used in foam packaging, disposable cups, and more.
7. **Other -** any plastic that does not fit into the other categories.

Recyclable plastic waste can be recycled through various processes such as sorting, cleaning, and melting to create new plastic products. The recycling process can help to reduce the amount of plastic waste that ends up in landfills or pollutes the environment, conserving natural resources and reducing greenhouse gas emissions.

However, not all types of plastic are equally recyclable, and some may require specialized facilities or processes to recycle. Additionally, the contamination of recyclable plastic waste with non-

recyclable materials can hinder the recycling process and reduce the quality of the recycled material. As such, proper recycling practices, including sorting and cleaning of plastic waste, are essential to ensure the maximum benefit from recycling efforts.

Plastic: A wealth from waste

Firstly, plastic is a highly versatile and durable material that can be molded into a wide range of products and used in many different applications, from packaging and construction to electronics and medical devices. This versatility and durability make it a valuable resource that can be used to create wealth from waste.

Secondly, plastic waste is a significant environmental problem, with millions of tons of plastic ending up in landfills and oceans every year, causing harm to wildlife and ecosystems. However, this waste can be repurposed and recycled into new products, reducing the need for new plastic to be produced and further reducing its environmental impact. By turning plastic waste into a resource, we can create wealth from what would otherwise be considered garbage.

Thirdly, recycling plastic can also create economic opportunities, providing jobs in the recycling industry and reducing the cost of raw materials for manufacturers. By creating a circular economy for plastic, we can create wealth and economic growth while also reducing environmental harm.

While plastic waste is a major environmental problem, there are some ways to create wealth from it. Here are a few examples:

1. **Recycling:** Recycling plastic waste can create wealth by reducing the need for new raw materials and generating revenue from selling recycled plastic. Recycling companies can turn plastic waste into new products such as plastic lumber, park benches, and even clothing.
2. **Waste-to-energy:** Plastic waste can be used to generate electricity through waste-to-energy processes such as incineration, gasification, and pyrolysis. These processes convert plastic waste into energy, which can be sold to power companies.
3. **Upcycling:** Upcycling involves taking plastic waste and turning it into a higher-value product. For example, used plastic bags can be turned into reusable shopping bags, or plastic bottles can be turned into jewellery.
4. **Biodegradable plastics:** Biodegradable plastics are made from natural materials such as corn-starch and can break down more easily than traditional plastics. This can create a market for companies that produce biodegradable plastics as an alternative to traditional plastics.

Multipronged approach for plastic waste management:

There are several multi-pronged approaches for plastic waste management, which can be implemented at different levels, including individual, community, and government levels. A combination of these approaches can help address the plastic waste crisis and create a more sustainable future. Some of these approaches are:

1. **Reduce plastic use:** One of the most effective ways to manage plastic waste is by reducing the amount of plastic we use. This can be achieved through a range of actions such as using reusable bags, water bottles, and food containers, avoiding single-use plastic items like straws and cutlery, and choosing products with less packaging.
2. **Recycle:** Recycling is another important approach to managing plastic waste. It involves collecting, sorting, and processing plastic waste to produce new products. Governments and communities can set up recycling programs and provide the necessary infrastructure for collection and processing of plastic waste.
3. **Encourage innovative solutions:** Innovation can play a key role in managing plastic waste. There are several innovative solutions, such as using biodegradable plastics or developing new technologies to convert plastic waste into energy or other useful products.
4. **Raise awareness:** Raising awareness about the impact of plastic waste on the environment and the importance of proper waste management is essential. This can be done through education campaigns, public awareness programs, and media.
5. **Policy and regulations:** Governments can implement policies and regulations to manage plastic waste. This may include bans on certain types of single- use plastics, implementing extended producer responsibility schemes, and setting up waste management regulations.
6. **Clean-up programs:** Cleaning up plastic waste from the environment can help prevent it from entering the ocean or causing harm to wildlife. Governments, NGOs, and communities can organize clean-up programs to remove plastic waste from beaches, rivers, and other areas.

Agricultural plastics: Recent development in waste management:

Agricultural plastics are used extensively in modern farming practices for various purposes such as mulching, irrigation, and protection of crops. However, the disposal of agricultural plastics after use has been a significant environmental issue for many years. Here are some recent developments in agricultural plastic waste management:

1. **Recycling:** Agricultural plastics, such as silage wrap, bale wrap, and greenhouse film, can be recycled into new products. In recent years, several companies have started to offer recycling programs for agricultural plastics, which involve collecting and processing the waste plastics into new products such as fence posts, furniture, and building materials.
2. **Biodegradable alternatives:** Biodegradable agricultural plastics are being developed as a more sustainable alternative to traditional plastics. These plastics can break down naturally in the soil, reducing the need for disposal and the environmental impact of plastic waste.
3. **Reuse:** Some types of agricultural plastics, such as silage bags and bale netting, can be reused several times before disposal. Farmers can wash and repair these plastics for reuse, reducing the need for new plastics and the amount of waste generated.

4. **Controlled incineration:** Controlled incineration is a waste management method that involves burning agricultural plastics in a controlled environment, where the emissions can be captured and treated to prevent environmental harm. This method can help reduce the amount of waste generated and prevent the release of harmful chemicals into the environment.
5. **Legislation and policy:** Governments are implementing legislation and policies to address the issue of agricultural plastic waste. In some countries, producers are required to take responsibility for the waste generated by their products and dispose of them appropriately.

Recent developments in agricultural plastic waste management show that there is a growing recognition of the importance of managing agricultural plastic waste in a sustainable and responsible manner.

Circular economy in Plastic waste management:

The theory of circular economy and its practice focuses on how never making plastics become waste (Qu *et al*., 2019). But despite the fact that plastics are kept away from the stream of waste and rechannelled into useful economic activities through the circular economy, plastics are still found to be a significant cause of environmental and social harm (Geyer et al., 2017).

Some important information about innovations where plastics are being monetized are as follows:

1. **Plastic-to-fuel technology:** Plastic-to-fuel technology involves converting plastic waste into fuel, such as diesel or gasoline. This technology not only reduces the amount of plastic waste but also provides a renewable source of energy for agricultural machinery.
2. **Biodegradable plastics:** Biodegradable plastics are being developed as a more sustainable alternative to traditional plastics. These plastics can break down naturally in the soil, reducing the need for disposal and the environmental impact of plastic waste.
3. **Plastic mulch recovery:** Plastic mulch recovery involves the use of specialized equipment to remove plastic mulch from the soil after the growing season. The recovered plastic can then be recycled or reused, reducing the amount of plastic waste generated.
4. **Plastic waste as soil amendment:** Plastic waste can be used as a soil amendment to improve soil quality and crop yields. Some studies have shown that adding plastic waste to soil can increase water retention, reduce soil erosion, and promote plant growth.
5. **Plastic waste as irrigation tubing:** Plastic waste can be repurposed as irrigation tubing for agriculture. This involves cleaning and cutting plastic waste into appropriate sizes and using it to irrigate crops. This reduces the need for new irrigation tubing and provides a sustainable use for plastic waste.
6. **Plastic waste as composting agent:** Plastic waste can be used as a composting agent to speed up the decomposition of organic matter. The high carbon content of plastic waste can

help balance the carbon-to-nitrogen ratio in compost, resulting in a more effective composting process.

Circular economy: Potential and opportunities in the context of Plastic Waste Management

Circular economy is a concept that promotes an economic system that is restorative and regenerative by design. In the context of plastic waste management, circular economy seeks to minimize the negative impact of plastic waste on the environment and human health by designing systems that prioritize reuse, recycling, and recovery of plastic waste.

The circular economy approach to plastic waste management involves several key principles, including:

1. **Design for circularity:** Designing products and packaging that are reusable, recyclable, and made from sustainable materials.
2. **Reduce, reuse, recycle:** Prioritizing waste reduction and reuse before recycling. Recycling should be considered as a last resort.
3. **Extended producer responsibility:** Encouraging producers to take responsibility for the environmental impact of their products throughout their lifecycle, including the end-of-life phase.
4. **Closed-loop systems:** Creating closed- loop systems that keep plastic waste in use for as long as possible, reducing the need for virgin materials and minimizing waste.
5. **Collaboration:** Encouraging collaboration between stakeholders across the value chain, including producers, recyclers, governments, and consumers.

Figure: Circular economy process
Source: https://www.acpolymers.com.au/about/

By adopting a circular economy approach to plastic waste management, we can reduce the negative impact of plastic waste on the environment and create a more sustainable future for all.

Extension strategies to deal with plastic waste:

Extension strategies can play a significant role in dealing with plastic waste by educating and engaging communities, businesses, and individuals in sustainable waste management practices.

Here are some extension strategies to deal with plastic waste:

1. **Public awareness campaigns:** Public awareness campaigns can be used to educate communities about the impacts of plastic waste on the environment and promote sustainable waste management practices such as recycling and reducing single-use plastics.
2. **Community-based recycling programs**: Community-based recycling programs can be established to encourage residents to recycle plastic waste. These programs can include the provision of recycling bins and the implementation of collection services.
3. **Education and training programs:** Education and training programs can be developed to educate businesses and individuals about sustainable waste management practices. These programs can include workshops, seminars, and online resources.
4. **Partnership building:** Building partnerships with local businesses, government agencies, and community organizations can help to promote sustainable waste management practices and increase the effectiveness of extension strategies.
5. **Incentives and rewards:** Incentives and rewards can be offered to encourage individuals and businesses to participate in sustainable waste management practices such as recycling and reducing plastic waste.
6. **Research and development:** Research and development can be conducted to explore new technologies and innovations for managing plastic waste more effectively and sustainably.

The Plastic Waste Management Rules 2022 India and its Impact on the Environment:

The Plastic Waste Management Rules (PWM) were introduced in 2016 by the Ministry of Environment, Forest and Climate Change in India. These rules aim to regulate the production, use, and management of plastic waste in the country, with the goal of reducing the negative impact of plastic on the environment and human health.

The Plastic Waste Management Rules 2022 India will have a far-reaching impact on the environment. The new rules will prohibit the use of certain types of plastic and mandate the recycling of others. They will also establish standards for the collection and disposal of plastic waste.The most significant change under the new rules is the prohibition of single-use plastic bags. This will include bags for shopping, as well as other disposable items like straws, plates, and cutlery. The production, sale, and use of these items will be banned from October 2nd, 2022. The new rules will also require manufacturers to use at least 40% recycled plastic in their products. This will help to reduce the demand for new plastic and encourage companies to recycle more of their waste. The impact of these changes on the environment will be significant. The reduction in single-use plastics will lead to less pollution and a smaller carbon footprint. The increased recycling rates will also help to conserve resources and protect wildlife habitats.

The Plastic Waste Management Rules, introduced by the Indian government, provide a strong regulatory framework for implementing circular economy principles in plastic waste management. The rules require producers to take responsibility for the end-of-life phase of their products, encouraging them to design products and packaging for circularity. The rules also prioritize waste reduction and encourage the development of waste management infrastructure, including collection,

sorting, and recycling facilities. By following the rules and adopting circular economy principles, India can reduce its plastic waste generation and achieve a more sustainable and resilient economy.

Some of the key provisions of the Plastic Waste Management Rules include:

1. **Extended Producer Responsibility (EPR):** Producers are required to take responsibility for the end-of-life management of their products and packaging. They must set up collection and recycling systems for their products and ensure that a certain percentage of their packaging is made from recyclable materials.
2. **Ban on certain types of plastic:** The rules ban the manufacture, sale, and use of plastic bags below a certain thickness and non-compostable multi-layered plastic.
3. **Plastic waste management infrastructure:** The rules require local authorities to set up and maintain a system for the collection, segregation, and disposal of plastic waste. The rules also require the establishment of waste processing facilities for the recycling and recovery of plastic waste.
4. **Public awareness and education:** The rules require the government and stakeholders to conduct awareness campaigns and educate the public about the impact of plastic waste on the environment and human health.
5. **Penalties for non-compliance:** The rules specify penalties for non-compliance, including fines, imprisonment, and cancellation of licenses.

The Plastic Waste Management Rules are an important step towards reducing the negative impact of plastic waste in India. The rules provide a strong regulatory framework for the management of plastic waste and encourage the adoption of sustainable practices in the production and consumption of plastic.

By shifting towards a circular economy model, India can create more sustainable pathways for tackling the plastic waste problem and reap the economic benefits associated with this model. At the heart of circular economies are efforts to end resource waste, reduce environmental impact and increase efficiency. Growing environmental concerns associated with the accumulation of plastic waste in the natural environment has incentivised considerable research into renewable alternatives, and more recently, alternative waste management strategies.

PLASTIC POLLUTION & ITS EFFECTS ON THE AQUATIC FLORA AND FAUNA

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Introduction

The effects of pollution on the ecosystem and public health are becoming monstrous, and they are only getting worse every other-day. It is the presence or introduction of substances or pollutants-like dangerous gases, chemicals, and particles-that have negative impacts on the environment. Numerous factors, including as commercial and industrial operations, transportation, agriculture, and household waste, can contribute to pollution. From soil contamination and biodiversity loss to air and water pollution, pollution may have disastrous repercussions. Pollution has negative effects on both the environment and human health, including chronic diseases like cancer and respiratory issues. Given the gravity of the situation, it is crucial to comprehend its root causes and consequences in order to take action to lessen its impacts and move towards a cleaner, healthier Earth.

Definition and types:

Pollution is defined as "Any substances in water, soil, or air that degrade the natural quality of the environment, offend the senses of sight, taste, or smell, or pose a health hazard" by the United States Environmental Protection Administration.

The main types of pollution and the specific pollutants that apply to each of them are given below:

- Air pollution is the atmospheric emission of chemicals and particles. Carbon monoxide, sulphur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides are typical gaseous pollutants that are created by industry and automobiles.
- **Electromagnetic pollution:** an excess of electromagnetic radiation that is not ionizing, such as that emitted by radio and television broadcasts, Wi-Fi, etc. Although there is no discernible influence on people, radio-astronomy and the safety systems of vehicles and aero planes may be affected.

- **Noise pollution:** Road noise, aero plane noise, industrial noise, and loud sonar.
- **Plastic pollution:** It is the buildup of plastic waste and micro plastics in the environment, which has a negative impact on animals, their habitats, or people.
- **Nuclear weapons production:** nuclear power generating, and other 20th-century atomic physics operations resulted in radioactive pollution. (See environmental actinides and alpha emitters.)
- **Water Pollution:** Intentional or accidental releases of industrial wastewater from commercial and industrial waste, discharges of untreated sewage and chemical contaminants, such as chlorine, from treated sewage, and releases of waste and contaminants into surface runoff flowing to surface waters (including urban runoff and agricultural runoff, which may contain chemical fertilizers and pesticides, as well as human feces from open drains) are all examples of water pollution.

Plastic Pollutants:

Our earth suffers greatly from the environmental problem of plastic pollution. Due to its adaptability and low cost, plastic is frequently utilized in a wide range of products, including packaging, home goods, and consumer goods. Plastic, on the other hand, takes hundreds of years to degrade, so it ends up in our seas, landfills, and other natural areas.

Following are some concerning data on plastic pollution:

- By weight, there may be more plastic in the ocean by 2050 than fish, according to a research by the Ellen MacArthur Foundation.
- According to a research from the University of California, Santa Barbara, 8 million metric tons of plastic are released into the ocean annually.
- There have been accounts of marine creatures consuming or being entangled in plastic debris, which has a disastrous effect on marine life.
- The ocean, lakes, and rivers are only a few of the water bodies that contain microplastics, which are minute plastic fragments less than 5 millimetres. They may be consumed by marine species, which might cause them to move up the food chain and endanger human health.

Sources of Plastic Pollutants/Pollution:

Human actions, such as the creation, use, and disposal of plastic items, are the main contributors to plastic pollution. The following list of sources for plastic contamination includes pertinent data:

1. Single-use plastics are a significant contributor to plastic pollution. Examples include straws, bags, bottles, and eating utensils. A United Nations research claims that 73% of all beach trash is plastic; with single-use plastics being the most often discovered materials.
2. Industrial Activities: The manufacture and production of plastics are significant sources of plastic pollution, with these industries producing significant volumes of plastic trash. The

International Energy Agency estimates that 368 million tons of plastic were produced worldwide in 2019, with 12% of that amount going towards packaging.

3. Improper Waste Management: Littering and unauthorized dumping of plastic waste are two examples of improper waste management that contribute significantly to plastic pollution. One garbage truck load of plastic is tossed into the ocean every minute, according to a research by the Ocean Conservancy, which estimates that 8 million metric tons of plastic enter the ocean annually.
4. Micro plastics: Less than 5 millimeter-sized plastic particles may be discovered in many different types of water, including the ocean, lakes, and rivers. Micro plastics are produced as bigger plastic garbage decomposes over time; they can be consumed by marine life, make their way into the food chain, and end up endangering human health.

Impact:

Oceanic pollution due to plastics is a major environmental issue that has gained widespread attention in recent years. Here are some facts and figures that illustrate the scale of the problem:

- More than 8 million tons of plastic enter the ocean each year. (National Geographic)
- It is estimated that by 2050, there will be more plastic in the ocean than fish by weight. (World Economic Forum)
- Plastic waste kills up to 1 million seabirds, 100,000 marine mammals, and countless fish each year. (National Geographic)
- Plastic pollution has been found in every ocean in the world, even in the most remote and pristine areas. (BBC)
- Microplastics, tiny pieces of plastic less than 5mm in size, have been found in sea salt, tap water, and even the air we breathe. (National Geographic)
- Plastic pollution has economic consequences as well, costing the tourism and fishing industries billions of dollars each year. (Ocean Conservancy)
- The top 10 rivers contributing to ocean plastic pollution are located in Asia, with the Yangtze River in China being the largest contributor. (The Ocean Cleanup)
- Single-use plastics, such as straws, bags, and bottles, are among the most common items found in ocean debris. (National Geographic).
- The Great Pacific Garbage Patch, a collection of plastic waste in the North Pacific Ocean, is estimated to be twice the size of Texas. (National Geographic).
- Plastic pollution is not only harmful to marine life, but it can also harm human health by entering the food chain. (National Geographic).

Oceanic Life affected:

The destructive impact of plastic pollution on ocean life is one of the most pressing environmental concerns of our time. Here is an in-depth analysis of the impact of plastics on ocean life, along with relevant statistics:

1. **Entanglement:** Marine animals such as sea turtles, seals, and dolphins can get entangled in plastic debris, leading to injuries, suffocation, and death. Plastic bags and fishing nets are among the most common items found in entanglement cases. According to a study, at least 1,000 sea turtles and marine mammals are killed every year due to plastic entanglement. (National Geographic)
2. **Ingestion:** Marine animals mistake plastic debris for food, leading to ingestion and blockages in their digestive system. Plastic fragments can also leach toxic chemicals into the animal's bloodstream, leading to organ damage and even death. A study found that 90% of seabirds have plastic in their stomachs. (National Geographic)
3. **Habitat destruction:** Plastic pollution can also destroy the natural habitat of marine animals. For example, coral reefs are highly sensitive to changes in their environment, and plastic pollution can damage the corals and other organisms that make up the reef. A study found that plastic pollution reduces the growth rate of corals and increases their susceptibility to disease. (ScienceDirect)
4. **Bioaccumulation:** Plastic debris can accumulate toxic chemicals such as bisphenol-A (BPA) and polychlorinated biphenyls (PCBs) from the water, leading to bioaccumulation in the food chain. When smaller organisms ingest plastic fragments, the toxic chemicals accumulate in their tissues, and as larger animals eat the smaller ones, the concentration of toxins increases. A study found that microplastics can lead to a 12% decrease in energy reserves in marine zooplankton. (ScienceDirect)
5. **Species loss:** The impact of plastic pollution on ocean life is not limited to individual animals. The loss of habitat and disruption of the food chain can lead to the extinction of entire species. A study found that plastic pollution is a significant threat to 17% of the marine species listed as endangered or vulnerable by the International Union for Conservation of Nature (IUCN). (ScienceDirect)
6. These statistics illustrate the devastating impact of plastic pollution on ocean life. Addressing this issue requires concerted efforts at individual, community, and global levels to reduce plastic waste, promote sustainable alternatives, and clean up existing debris from the oceans.

Limiting the use of plastics and alternatives to plastic:

There are several substitutes to plastics that are more environmentally friendly and sustainable. Here are some examples:

1. **Bioplastics:** Bioplastics are plastics made from renewable sources such as starch, cellulose, and vegetable oil. They are biodegradable, compostable, and can be recycled. However, it is important to note that not all bioplastics are created equal, and some may still have a negative impact on the environment.

2. **Glass:** Glass is a sustainable alternative to plastic as it is infinitely recyclable and does not leach harmful chemicals into the environment. Glass is also a durable material that can be used repeatedly, reducing waste.
3. **Metal:** Metal containers, such as stainless steel or aluminum, are a sustainable alternative to plastic containers. They are durable, reusable, and recyclable.
4. **Natural fibers:** Natural fibers, such as cotton, hemp, and jute, can be used to make reusable bags, packaging, and other products as an alternative to plastic. These materials are biodegradable, compostable, and renewable.
5. **Paper:** Paper is a sustainable alternative to plastic for packaging and other products. It is recyclable, biodegradable, and can be made from renewable sources such as wood pulp and recycled paper.

Some newer methods to limit the plastic usage without decreasing the effectiveness are as follows:

1. In addition to the measures mentioned earlier, there are also newer methods being developed to further reduce plastic usage and save oceanic flora and fauna. Here are some of these methods:
2. **Biodegradable Plastics:** Biodegradable plastics are designed to decompose in the environment, reducing the amount of plastic waste that ends up in the ocean. These plastics can be made from natural materials such as corn starch or algae. However, it is important to note that some biodegradable plastics require specific conditions to break down, and improper disposal can still contribute to pollution. (BBC)
3. **Refillable and Reusable Containers:** Refillable and reusable containers, such as water bottles or coffee cups, are a great alternative to single-use plastic. Many coffee shops and restaurants now offer discounts for customers who bring their own cups, and there are also refill stations for water bottles in public areas. (The Guardian)
4. **Circular Economy:** The circular economy is a system where resources are kept in use for as long as possible and waste is minimized. This can involve reducing the amount of plastic used in products, designing products to be easily repaired or recycled, and developing new recycling technologies. (Ellen MacArthur Foundation)

5. **Plastic-Free Packaging:** Many companies are now exploring plastic-free packaging options, such as paper or cardboard, to reduce the amount of plastic waste generated. For example, Lush Cosmetics has introduced "naked" products that are sold without packaging, and Loop, a new shopping platform, offers products in reusable containers that are picked up and refilled by the company. (The Guardian)
6. **Innovation:** There are also many innovative solutions being developed to reduce plastic usage, such as edible packaging made from seaweed or mushrooms, or biodegradable fishing nets made from natural fibers. (National Geographic)

These newer methods show that there are many ways to reduce plastic usage and save oceanic flora and fauna. However, it is important to remember that changing behavior and reducing plastic waste will require a collective effort from individuals, companies, and governments alike.

Conclusion:

In conclusion, plastic pollution in the ocean is a significant problem that has a negative impact on marine life, ecosystems, and the environment as a whole. However, there are various measures that can be taken to reduce plastic pollution both in the ocean and in everyday life.In recent years, there has been a growing awareness of the issue of plastic pollution, leading to the implementation of measures such as plastic bag bans, the use of alternative materials to plastic, recycling, clean-up efforts, education and awareness campaigns, and the development of newer methods such as biodegradable plastics, refillable and reusable containers, the circular economy, plastic-free packaging, and innovative solutions.

While these measures are important, it is important to note that reducing plastic pollution requires a collective effort from individuals, companies, and governments. Everyone can play a role in reducing plastic waste by making small changes in their daily habits such as using a refillable water bottle, bringing their own bags when shopping, and choosing products with minimal packaging. Companies can adopt sustainable practices and develop innovative solutions, while governments can implement policies and regulations to reduce plastic waste and promote sustainable practices.

Overall, reducing plastic pollution in the ocean and in everyday life is a long-term and ongoing process that requires a comprehensive and collaborative approach. By taking action and making conscious choices, we can all contribute to a cleaner and healthier environment for future generations.

EFFECT OF PLASTIC POLLUTION IN CLIMATE CHANGE

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What is Climate?

"Do not harm the environment;
Do not harm the water and flora;
Earth is my mother, I am her son;
May the waters remain fresh, do not harm the waters...
Tranquility be to the atmosphere, to the earth, to the waters, to the crops and to the vegetation."

This Vedic wisdom teaches us a philosophy and human governance based upon the principleof natural ecosystem. Welfare of each element of the eco-system is welfare of each member of the community.Ultimately, survival of each element and the mother earth is dependent on it.

Climate is the pattern of variation in temperature, humidity, atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological variables in each region over long periods. A region's climate is generated by the climate system, which has five components: atmosphere, hydrosphere, cryosphere, lithosphere, and biosphere. The climate of a location is affected by its geographical location and its environment.Climate pattern is responsible for a healthy ecosystem and the ecosystem gets disturbed if there is a change in the climate pattern, which is termed as climate change.

What is Climate Change?

Climate Change is normally known as the variation in global and regional climates over time. It reflects changes in the variability or average state of the atmosphere over time scales ranging from decades to millions of years.Global Warming and Climatic Change refer to an increase in average global temperatures. National events and human activities are believed to be contributing to an increase in average global temperatures. This is caused primarily by an increase in "greenhouse" gases such as CO_2, CH_4, N_2O, CFC's etc.

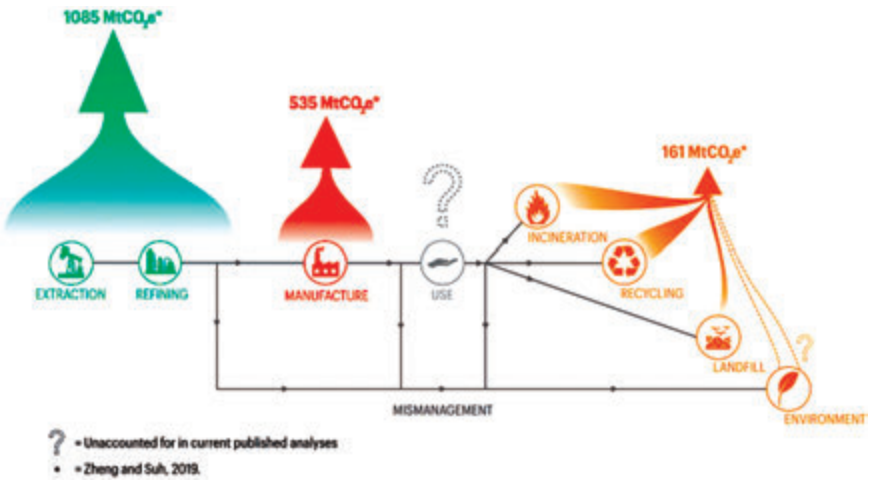
Plastics and the Fossil Industry

Plastic production and consumption rely on fossil fuels, which emit greenhouse gases that cause global warming.As 99% of plastics are created from fossil fuel feedstocks, plastic production is closely linked to the petrochemical industry. Petrochemicals are expected to become the largest driver of global oil demand growth from now through 2030. While the international community is striving to address climate change by moving away from fossil fuels in the energy and transportation sectors,

plastics should not be ignored, as they are tightly linked to the fossil industry. According to the World Economic Forum, plastics account for 4-8% of annual global oil consumption and could rise to 20% by 2050.

Plastic's Contribution to Climate Change

Plastics are threatening the ability of the global community to keep global temperature rise below 1.5°C, as greenhouse gases (GHG) are emitted throughout the plastic life cycle. Indeed, extraction, refining and manufacture of plastics are all carbon intensive activities. In 2015, CO_2 and other GHGs emissions from plastic production reached 1.96 Gt of CO_2e, for a cost of $341 billion annually (Minderoo-Monaco Commission on Plastics and Human Health, 2023).



At the disposal stage, incineration of plastic waste releases significant GHG into the atmosphere, alongside toxic pollutants. Other disposal methods, including recycling, also come with their share of GHG emissions. The rapid global growth of the plastic industry, largely fueled by natural gas, undermines efforts to reduce carbon pollution and prevent a climate catastrophe. Estimates indicate that GHG emissions from plastics could reach about 13% of the entire remaining carbon budget by 2050 (CIEL, 2019). Without a plastic cap, OECD projects GHG emissions from plastic to increase to 4.3 Gt CO_2e. Plastic in the oceans may also interfere with the ocean's capacity to absorb and sequester carbon dioxide, thus creating another pathway through which plastic pollution contributes to accelerating climate change. Various ecosystems, such as the ocean and mountain areas, are particularly vulnerable to both climate change and plastic pollution, and the combination of both is a significant stress factor on biodiversity.

The plastic lifecycle can be divided into essentially four buckets.

- Fossil fuel extraction and transportation
- Production and manufacturing of plastic
- Disposal of plastic waste
- Ongoing environmental impact of plastic

Plastic pollution

Plastic pollution is the accumulation of plastic objects and particles (e.g. plastic bottles, bags and microbeads) in the Earth's environment that adversely affects humans, wildlife and their habitat. Plastics that act as pollutants are categorized by size into micro-, meso-, or macro

debris. Plastics are inexpensive and durable, making them very adaptable for different uses; as a result, manufacturers choose to use plastic over other materials. However, the chemical structure of most plastics renders them resistant to many natural processes of degradation and as a result, they are slow to degrade. Together, these two factors allow large volumes of plastic to enter the environment as mismanaged waste and for it to persist in the ecosystem.

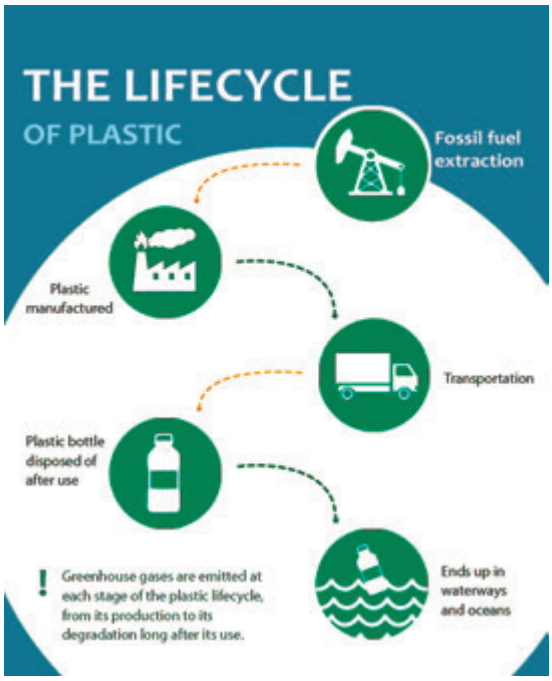


Fig. The Plastic Lifecycle. Schematicsrepresent the estimated amounts of greenhouse gases released in CO_2e at each stage of the plastic life cycle. The amount stored during use and released when plastic ends up in the natural environment is largely unknown. Data taken from Zheng and Suh (2019).

Plastic pollution can afflict land, waterways and oceans. It is estimated that 1.1 to 8.8 million tons of plastic waste enters the ocean from coastal communities each year.It is estimated that there is a stock of 86 million tons of plastic marine debris in the worldwide ocean as of the end of 2013, with an assumption that 1.4% of global plastics produced from 1950 to 2013 has entered the ocean and has accumulated there.Some researchers suggest that by 2050 there could be more plastic than fish in the oceans by weight. Living organisms, particularly marine animals, can be harmed either by mechanical effects such as entanglement in plastic objects, problems related to ingestion of plastic waste, or through exposure to chemicals within plastics that interfere with their physiology. Degraded plastic waste can directly affect humans through both direct consumption (i.e. in tap water), indirect consumption (by eating animals), and disruption of various hormonal mechanisms.

As of 2019, 368 million tons of plastic is produced each year; 51% in Asia, where China is the world's largest producer. From the 1950s up to 2018, an estimated 6.3 billion tons of plastic has been produced worldwide, of which an estimated 9% has been recycled and another 12% has been incinerated. This large amount of plastic waste enters the environment and causes problems throughout the ecosystem; for example, studies suggest that the bodies of 90% of seabirds contain plastic debris. In some areas there have been significant efforts to reduce the prominence of free range plastic pollution, through reducing plastic consumption, litter cleanup, and promoting plastic recycling.

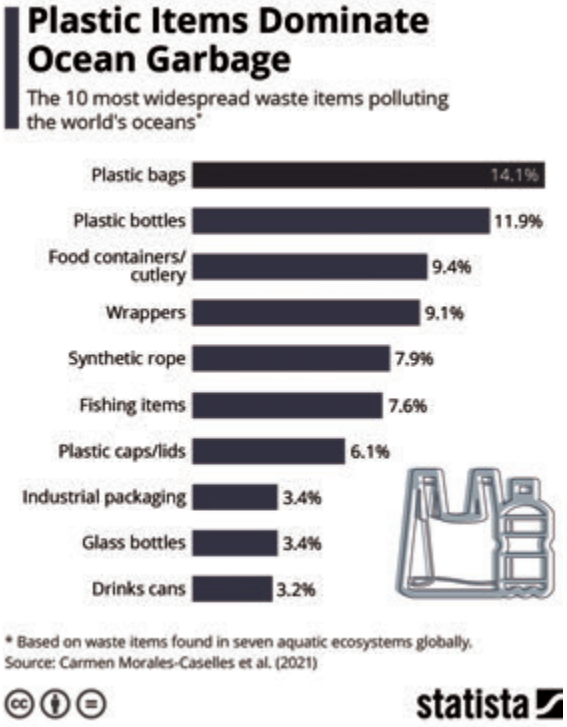
The United States National Academy of Sciences estimated in 2022 that the worldwide entry of plastic into the ocean was 8 million metric tons of plastic per year. A 2021 study by The Ocean Cleanup estimated that rivers convey between 0.8 and 2.7 million metric tons of plastic into the ocean, and ranked these river's countries. The top ten were, from the most to the least: Philippines, India, Malaysia, China, Indonesia, Myanmar, Brazil, Vietnam, Bangladesh, and Thailand.

Against the backdrop of this massive expansion in petrochemical and plastic production, CIEL along with a number of other organizations released in 2019 the report "Plastic & Health: The Hidden Costs of a Plastic Planet" that outlined the human health impacts of the plastic life cycle. Later in 2019, CIEL released a report "Plastic and Climate", which talks about the climate impact across the plastic lifecycle.

Waste plastic also causes climate change

- Greenhouse gases are emitted at each stage of the plastic lifecycle.
- Plastic pollution is a significant and growing threat to the earth's climate.
- Stopping the expansion of petrochemical and plastic production and keeping fossil fuels in the ground is a critical element in addressing the climate crisis.

Getting rid of all this plastic also causes problems for the planet. Just 16% of plastics are recycled – the rest goes to landfill for incineration, or is just dumped. Much of the plastic that doesn't make it to the recycling plant ends up in our rivers and ocean. Not only is this a danger to the animals and plants whose habitats have become aquatic garbage patches, but it also poses a threat to the climate, as plastic releases greenhouse gases as it slowly breaks down. Sunlight and heat cause it to release methane and ethylene – and at increasing rate as the plastic breaks down into ever smaller pieces.



On top of this, research suggests that microplastics affect the ability of marine microorganisms to absorb carbon dioxide and release oxygen. At least half of Earth's oxygen comes from the ocean, mostly produced by plankton. These tiny organisms also capture carbon through photosynthesis, making our ocean a vitally important carbon sink. Microplastics affect the ability of these organisms to grow, reproduce and capture carbon. And by grazing on microplastics, these plankton could further accelerate the loss of ocean oxygen.

This means the pernicious effects of all this plastic pollution on the marine environment are particularly concerning. A plastic-choked and warming ocean will create a negative feedback loop where plant and animal life suffer, less carbon dioxide is absorbed and our ability to rein in climate change is further hampered.

Negative Feedback Loops: Plastic waste can lead to negative feedback loops, where it promotes the absorption and buildup of greenhouse gases by reducing the reflective capacity of snow and ice, leading to warming and eventually more melting. This can further contribute to the release of methane and other greenhouse gases, leading to a further acceleration of global warming.

Soil Degradation: Plastic waste can lead to soil degradation, which reduces the capacity of soil to store carbon. Soil that has been degraded due to plastic pollution has a lower capacity to absorb carbon dioxide, thus increasing the concentration of greenhouse gases in the atmosphere.

Solution toplastic pollution on climate change problem: One solution to plastic pollution is to reduce the production and use of plastic items, especially single use plastics. For instance, consumers can opt for products with less packaging or avoid buying single-use plastics. Governments also need to set regulations for industries to manufacture eco-friendly products and incentivize companies that adopt biodegradable plastic technology. Another solution is to establish recycling programs for plastics. Recycling programs can reduce the amount of plastic waste that ends up in landfills, oceans, and other natural habitats. Recycling plastic not only reduces waste but also conserves resources such as water, energy, and oil.

Plastics and Net Zero Emissions

Most plastics are manufactured using petrochemicals. About 10% of all the oil and gas produced in the world goes towards making plastics, which ultimately accounts for 3.5% of all greenhouse gas emissions. While most of these emissions are generated by the production and manufacturing of plastic products, some come from their disposal. About a quarter of all plastic waste is incinerated, causing direct emissions, and 55% is discarded either into a landfill or straight into the environment. Landfills are not sustainable, and up to 40% of landfill waste is potentially burned in open fires in a way that releases carbon dioxide and other pollutants.

The plastics industry can act to reduce related carbon emissions to net-zero; there are several innovative, low-carbon feedstocks that are potential alternatives to virgin petrochemicals. Some examples include wood, corn starch, agricultural by-products, recycled plastics, and even direct production using existing carbon dioxide emissions. Polycarbonate polymers, for example, can be made up of as much as 50% carbon dioxide, and can replace conventional polyurethanes used for housing insulation, foams and fillers, locking up substantial amounts of CO2 for decades.

Conclusion

That brings us to high priority actions we can take now:

- End the production and use of single use disposable plastic.
- stop the development of new oil gas and petrochemical infrastructure.
- foster the transition to zero waste communities and
- implement extended producer responsibility as a critical component of circular economies and
- force and adopt ambitious targets to reduce greenhouse gas emissions from all sectors and we need to do this while avoiding distractions like pyrolysis and chemical recycling and carbon capture use and storage.
- Adopt ocean Cleanup Technologies: Ocean cleanup technologies such as floating barriers, booms, and skimmers are being developed to collect plastic waste from oceans and

waterways. Researchers are testing new materials and designs to improve the efficiency of these technologies.

- A circular economy is an economic system that aims to minimize waste and maximize the use of resources. Researchers are studying how circular economy principles can be applied to the plastic industry to reduce waste and promote recycling.
- Green chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. Researchers are exploring the application of green chemistry principles to the development of plastic materials, reduction of plastic waste, and recycling processes.
- Plastic Taxation: Researchers are studying the effectiveness of plastic taxation policies that impose a tax on single-use plastics or plastic products that are difficult to recycle. These policies can encourage individuals and businesses to reduce their use of plastics and promote the development of eco-friendly alternatives.
- Bioplastics are plastics made from renewable raw materials such as corn starch, sugarcane, or vegetable fats and oils. Researchers are studying the development of bioplastics that are more environmentally friendly and cost-effective than traditional plastics.

In conclusion, researchers are exploring a range of innovative solutions to address plastic pollution, including circular economy principles, bioplastics, incentivized recycling, green chemistry, and plastic taxation policies. By combining these solutions with policies and regulations, we can work towards a more sustainable future with less plastic waste.

SOLUTIONS FOR **PLASTIC POLLUTION**

Dillip Kumar Mohanty
Former Add. General Manager, BHEL

Plastic pollution is the accumulation of plastic objects and particles (e.g. plastic bottles, bags and microbeads) in the Earth's environment that adversely affects humans, wildlife and their habitat. Plastics that act as pollutants are categorized by size into micro-, meso-, or macro debris. Plastics are inexpensive and durable, making them very adaptable for different uses; as a result, manufacturers choose to use plastic over other materials. However, the chemical structure of most plastics renders them resistant to many natural processes of degradation and as a result they are slow to degrade. Together, these two factors allow large volumes of plastic to enter the environment as mismanaged waste and for it to persist in the ecosystem.

Plastic pollution can afflict land, waterways and oceans. It is estimated that 1.1 to 8.8 million tonnes of plastic waste enter the ocean from coastal communities each year. It is estimated that there is a stock of 86 million tons of plastic marine debris in the worldwide ocean as of the end of 2013, with an assumption that 1.4% of global plastics produced from 1950 to 2013 has entered the ocean and has accumulated there. Some researchers suggest that by 2050 there could be more plastic than fish in the oceans by weight. Living organisms, particularly marine animals, can be harmed either by mechanical effects such as entanglement in plastic objects, problems related to ingestion of plastic waste, or through exposure to chemicals within plastics that interfere with their physiology. Degraded plastic waste can directly affect humans through both direct consumption (i.e. in tap water), indirect consumption (by eating animals), and disruption of various hormonal mechanisms.

Plastic pollution has become one of the most pressing environmental issues, as rapidly increasing production of disposable plastic products overwhelms the world's ability to deal with them. Plastic pollution is most visible in developing Asian and African nations, where garbage collection systems are often inefficient or nonexistent. But the developed world, especially in countries with low recycling rates, also has trouble properly collecting discarded plastics.

Plastic trash has become so ubiquitous it has prompted efforts to write a global treaty negotiated by the United Nations.

But all hope is not lost, and it is certainly not too late. While there are ways in which individuals can reduce their use of plastic in their daily activity, science and technology have allowed us to push the boundaries of what we thought was possible. Collective action is imperative. In 1987, the Montreal Protocol was introduced to prevent further damage caused to Earth's ozone layer. Over a period of time, humanity was able to phase out over 98% of the harmful substances that were causing the damage, preventing approximately 2 million cases of skin cancer as a result. If we were able to come together as we did in 1987, we can collectively tackle the plastic pollution problem. Researchers round the world have come together and the below 10 ways are the most preferred ways of tackling the pressing matter of plastic pollution in the world -

1. The Ocean Clean-up

The Ocean Clean-up is an excellent example of collective action. Inspired by a scuba diving trip in Greece, Dutch CEO Boyan Slat created the organisation consisting of a large team of people and technology designed to effectively collect plastic from the Great Pacific Garbage Patch. Using what is called the System 001, which consists of 600m-long floating structures intended to contain marine debris and designed to collect microplastics, one of the problematic forms of plastic and can be dangerous to both marine animals and humans if ingested, the system relies on wind and ocean currents to collect the plastic. Upon collection, the plastic waste is transported by a vessel back to land, to be then recycled.

Currently located in the garbage patch between Hawaii and California, the aim of The Ocean Clean-up is to deploy their system to the four other garbage patches located over the world, and hopefully clean up 50% of the plastic in the Great Pacific Garbage Patch within five years.

2. NASA Satellite Technology

Concentrations of ocean plastic can now be detected by NASA satellite technology that was created in 2016. This ground-breaking research method can be fundamental in tracking and managing ocean plastic debris and one of many crucial scientific solutions to plastic pollution. NASA's Cyclone Global Navigation Satellite System, also known as CYGNSS, was originally created to predict hurricanes by monitoring tropical wind speed over the ocean. Scientists discovered that this technology can detect the concentration of microplastic in the water by measuring the surface of the water. It will also provide a huge contribution to further research on the effects of microplastic on the ecosystem, help non-profit and private organisations clean up the sea, and protect aquatic life.

3. The Plastic-eating Enzyme

One of the most important scientific solutions to plastic pollution that have emerged is the plastic-eating enzyme. In Japan 2016, a scientist discovered a plastic-eating enzyme that was capable of breaking down Polyethylene terephthalate (PET) – the most commonly used type of plastic. This enzyme, known as IdeonellaSakaiensis 201-F6, is a bacteria that can digest plastic by secreting an enzyme called PETase, and ingesting the carbon in PET to be used as a food source. Though the breakdown process remains to be relatively slow, scientists have been working to speed it up. An international team of scientists have been able to modify the molecular composition of the enzyme, and tweak it to consume PET 20% faster than it originally did.

4. Plastic-eating Mushrooms

A darkly pigmented species of fungus, known as Aspergillus Tubingensis, has been found to contain agents that can degrade polyurethane (PU). Samantha Jenkins, lead biotech engineer for bio-manufacturing firm Biohm was studying different types of fungus in a research project, when she came across the plastic-eating fungus and found the fungus had eaten its way through the plastic sponge that was used to seal it. Jenkins is in the process of testing the fungus on PET and PU plastic and discovered the fungus to populate as it consumes more plastic, potentially creating a new source of biomaterial "for food, or feed stocks for animals, or antibiotics".

5. Magnetic Coils

Scientists have created a magnetic coil that is able to target microplastics in the ocean. This experimental nanotechnology is able to break down microplastic in the water without causing any harm to marine life. Thinner than a human hair, these coils resemble bed springs under a microscope, and are coated in nitrogen and a magnetic metal called manganese. When they react with oxygen molecules, they attack plastic and can help to break it down. Xiaoguang Duan, a co-author of this study found that nano-coils have a 30% to 50% reduction rate in microplastics over a period of eight hours in early experiments.

6. Converting to Fuel

Australian company Licella Holdings has developed a new patented technology, known as the Catalytic Hydrothermal Reactor (Cat-HTR), that can convert unrecyclable plastic into oil, it has been able to melt plastic and convert it into liquid fuel. Through a process similar to a commercial-sized pressure-cooker, it reduces plastic to its component parts, producing a range of materials including oils, waxes and plastics that can be turned into other plastic products or fuels.

What makes this technology so unique is its versatile nature. No plastic is a match for this device. The Cat-HTR chemically recycles mixed plastics without the need to separate the different plastic types. This includes end-of-life plastic that would otherwise be sent to landfills, incineration or end up in our oceans. It allows plastic waste to be recycled over and over again and on a commercial scale, and could convert 20,000 tonnes of plastic waste annually. However, critics have labelled the technology as an environmental trade-off as the process may produce further carbon emissions.

7. Converting to Roads

One of the many scientific solutions to plastic pollution is to convert waste into roads. A project known as PlasticRoad, created a bike path in the Dutch city of Zwolle and a road in Overjissel in 2018 using 70% recycled plastic. The plan is to increase this to 100%. The project has been proven successful as plastic is more durable than asphalt and requires less heavy equipment and time to install, which makes its carbon footprint smaller. PlasticRoad intends to carry on designing, creating and supplying these sustainable, climate-proof and circular roads, made from municipal plastic waste and "with the smallest possible negative impact on our planet and natural resources."

8. Substitute with Seaweed

One of the most significant scientific solutions to plastic pollution to emerge in recent years is bioplastic. A plastic alternative comprised of materials produced from renewable biomass sources. Indonesian start-up company Evoware has been researching ways of converting seaweed into a bioplastic. They work with local seaweed farmers to create a range of different types of packaging such as sandwich wraps, burger wraps, sachets for spices, and soap, which can be dissolved in hot water, and in some cases, edible. Indonesia produces 10 million tonnes of seaweed each year and could reach up to 19 million tonnes by 2020, which could help supply Evoware's expanding efforts.

Despite the innovative creativity behind such a thoughtful invention, these seaweed-based substitutes are not without its challenges. For example, Evoware's edible seaweed-based Ello Jello cone can be up to five times more expensive than ordinary crepe cones. Additionally, it still uses wrappings of plastic and paper to preserve its texture.

9. Social Plastic Policies

A social enterprise known as Plastic Bank is paying above-market rates for plastic waste. They act as a convenience store for the world's poor communities, and accept plastic waste as a form of currency. Their recycling ecosystem is sustained through the sale and use of what they call "Social Plastic®". This encourages people to collect ocean-bound plastic before it enters the waterways, and it can be traded for social benefits, including money, food and other services (such as school fees). Plastic Bank aims to make plastic too valuable to throw away. Upon collection, plastic waste will then be sold to corporations, who will pay around three times more than what plastics normally cost.

10. Nicholas Institute's Plastic Technology Inventory

A study released by the Nicholas Institute addressed the gap between knowledge for technology to tackle plastic pollution, and created a comprehensive inventory of 52 technologies currently being used or in development to prevent the leakage of plastic pollution or collect existing plastic pollution. The study concluded that both the prevention of plastic from entering waterways and plastic collection are matters of urgency, highlighting the importance of ensuring the care of aquatic systems and human health.

Two examples from this list include Plastic Fischer Trash Boom and Hoola One. The former was created in Germany in 2019, whose technology aims to collect microplastics from the water, while Hoola One was a vacuum created in Canada in 2019, intended to extract microplastics and macro-plastics from marine environments.

PLASTIC POLLUTION: CHALLENGES AND OPPORTUNITIES

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Plastic pollution is the accumulation of plastic objects and particles in the environment that harms wildlife, natural and wildlife habitats, and mankind. Plastic pollution at present is one of the most stressful environmental issues the world faces today. As most of the plastics that we use don't break down and dissolve easily, it is slowly filling up our oceans, which will take centuries to disintegrate, posing tremendous issues for aquatic life, human health and the marine ecosystem. Plastic pollution is posing threats for generations to come. If our current rate of pollution continues, experts predict that there will be more plastic than fish in the ocean by 2050.Pollution of plastic is a new problem for the scientific community of the 21st century. Latest researches in this field are to solve the problems of plastic pollution and its reuses. The present review focuses on the current challenges and possible remedial measures towards curbing plastic pollution. There are many solutions to plastic pollution that we can participate in today. This article covers some of the basic facts about plastic pollution and provides several beneficial plastic pollution solutions that everyone can take part in.

Introduction

Plastics, the term refers to pliable and easily shaped. These are the polymers of simple molecules. Unlike from naturally occurring polymers like cellulose these are synthetically prepared. The material is designed to be cheap, strong, light weight and flexible. In fact the first synthetic plastic was invented for a prize money that would be given to anyone who can provide a substitute for ivory that were to be used in the sports of billiards. It was invented by John Wesley Hyatt in 1869 who then wasn't aware that the product he invented to win an award of $ 10,000 would create a problem whose solution would cost millions of dollars today. Plastics in the 21st century has become a part of daily lifestyle of each individual; today some make money by manufacturing it, some by disposing it and some by repurposing it for other works. Plastics have been so much embedded in our life that disposing it has becoming a nightmare. There have been studies of finding microplastics in ocean, food, water and even in blood. These microplastics that are present inside the body are known to cause damage to the cell's metabolism and proper functioning of the body. They also have been found in the faeces of babies and adults. Often times when we throw food items in polythene bags outside we are indirectly allowing animals to eat plastics as a result of which their digestive system gets clogged as these bags are forced. Plastics are also a very important invention as it has made the invention of very stable and better plastics over the time. If we realize, plastics isn't the problem but its improper usage and disposal after use is the main problem leading to plastic pollution. Awareness

and Avoidance is considered as possible solutions today. Plastics is also a boon in today's world it is used in various fields like surgeries, housing, currency manufacturing, products packaging, electrical appliances and in lot more unimaginable products.

Impact of plastics on wildlife and human health

1. **Entanglement**: The entrapping, encircling or constricting of marine animals by plastic debris. Entanglement cases have been reported for at least 344 species to date, including all marine turtle species, involving more than two-thirds of seal species, one-third of whale species, and one-quarter of seabirds. Entanglement by 89 species of fish and 92 species of invertebrates has also been recorded. Entanglements most commonly involve plastic rope and netting and abandoned fishing gear.
2. **Ingestion**: Ingestion of plastic can occur unintentionally, intentionally, or indirectly through the ingestion of prey species containing plastic. Ingestion of plastics can have various impacts on organism health. Consuming large volumes of plastic can greatly reduce stomach capacity, leading to poor appetite and false sense of satiation. Plastics can also perforate the gut, causes ulcerative lesions, or gastric rupture or mucosal erosions, and ultimately leads to death.
3. **Interaction**: Interaction includes collisions, obstructions, abrasions or use as substrate. There are multiple scenarios where this can have an impact on organisms. Fishing gear, for example, has been shown to cause abrasion and damage to coral reef ecosystems can also be impacted by plastics following interference of substrate with plastics (impacting on light penetration, organic matter availability and oxygen exchange).
4. **Microplastics:** In the case of microplastics (particles smaller than 4.75 millimetre in diameter), the major issue is ingestion. Ingestion of microplastics have been shown to occur for many organisms. This can occur via several mechanisms, ranging from uptake by filter-feeders, swallowing from surrounding water, or consumption of organisms that have previously ingested microplastics. When organisms ingest microplastics, it can take up space in the gut and digestive system, leading to reductions in satiety. This feeling of fullness can reduce dietary intake.

Possible remedial measures to combat plastic pollution

1. **Recycle:** Plastics are not easily biodegradable; we can direct the companies that produce this to setup a recycle plant where all these plastics are to be cleaned and reused in production or are to be used in making newly designed products that have multipurpose uses. Companies that manufactures do not mention their names on the product which must be made mandatory and they must be complied to take back and recycle it.
2. **Biofuel:** Plastics are made from natural materials like Cellulose, Coal, Natural gas, Salt and Crude Oil. Due to usage of such components in the production of plastics they can be industrially processed into Biofuel. It can be produced to be an alternative to regular purpose fuel like kerosene, coal etc. In pyrolysis using high temperature and pressure the polymeric structure of a plastic is broken down into oligomeric and monomeric units. These can be purified from

contaminants and can be reproduced into fuel. Using this technique, we can get at least 800 litres of fuel from one ton of plastic waste a research study enlightens.

3. **Reduce:** Avoidance for the use of plastic is the most reliable solution for solving the plastic pollution issue. We do feel cheated when someone makes profit from our carelessness until and unless we realize it. The companies that manufacture plastics cheat us in similar ways; they are not making their products refillable on a "once more strategy" or on a subscription basis. Rather they rely more upon "single use and throw strategy more". For an example daily used products such as medicines that are required in large amounts can be provided in plastic vials with proper information about the drug and how to take it. It can also have stickers with QR codes that can link the patients with the pharmacy if the medicine is rare or is required by the patient frequently. Avoidance of the use of plastic is a two-way journey it connects both the manufacturer as well as the consumer. Reducing the use of plastics by taking proper care and doing proper utilization of the plastics artifacts we already have can help to reduce the plastic pollution. Rather purchasing a low quality single use plastic artifact we should purchase a high quality multipurpose long lasting artifact, if we just realize that we don't actually need more of a cheap thing rather than we need less of a good thing then to an extent plastic pollution can be avoided. Areas where we can reduce the usage of plastics are always having a carry bag around with us or using biodegradable or paper bags that can be composted. Less drinking from packaged water bottles or cold drinks.

4. **Reuse:** Some plastics being robust, stable and flexible have the ability to be reused if they are grinded into small plastic granules. In this way they can act as material for production of new plastic products. Technology and production should be designed in such a way that the output of manufactured product should be less than or equal to the input of raw materials.

5. **Repurposable:** The plastics that have huge probability of ending into waste can be designed in such as way as they serve for more than one purpose by altering their current design so that they can act as a collectible or as a storage for something collective or important. In this way the likeness of them ending up as garbage will get reduced. Another example can be used to avoid pollution caused by candy wrappers if the candy manufacturers provide their product in a vial that has been designed to have multiple uses; once the candy is finished like designing candy vials in such a way that it can be used for collecting coins, keeping memory cards and small but important objects like pen drives or even get candies again on returning the vial and paying for more candies, this can help raise concerns about proper disposal of waste among the upcoming generation.

6. **Microbial and fungus mediated plastic degradation:** Recently, Studies by scientists have discovered enzymes that are found in microbes and some annelids that can degrade plastics. Such enzymes can be extracted and using bioreactors these enzymes could degrade plastics gradually. In oceans a bacterium called *Ideonella sakaiensis* has been researched upon its plastic degradation and this finding is promising for solving the upcoming problems of plastic pollution. Large amount of plastic has been dropped into the environment over the years, and once it's

been into the environment, many centuries will pass before it degrades. *Aspergillus tubingensis*, a plastic eating fungus that lives in the soil. It secretes enzymes which help to break down the polymer chains that hold plastic together. The research is still continuing about the optimal condition for this organism to thrive in, after which, it will be introduced to begin the process of plastic eating.

7. **Road Construction:** The road pavements for developing countries are made up of bitumen. Countries like India need to build new roads and pavements for better connectivity among the states. Using waste plastics for the creation of new roads proves to be stable, weatherproof and resistant to stress and strain from vehicles. It results in good quality roads and can be a solution to reduce plastic pollution as well managing the current plastic pollution.
8. **Incineration:** Over 60 percent of used plastic medical equipment is burnt rather than dumped in a landfill as a preventative measure to reduce the transmission of infections. This has significantly decreased the quantity of plastic waste from medical equipment.
9. **Avoid Using Bottled Water:** People who stay outdoors throughout the day keep themselves hydrated using plastic water bottles, which are thrown to dustbin after use. For this reason, we should carry a reusable bottle with us.
10. **Bioplastics:** Bioplastics are plastic materials made up of plants, typically corn starch and bamboo fibres, instead of oil and other natural materials. They possess similar properties to traditional plastics, many of which are recyclable and biodegradable in industrial landfills, and tend to have a lower environmental impact as the plants used do not require pesticides or chemicals to grow.
11. **Ocean Cleanup:** Ocean plastic pollution is on the way to triple by 2040, according to a 2020 report. About 11 million metric tons of plastic enter our oceans every year, causing serious damage to wildlife habitats and harm to humans and animals. While the National Ocean and Atmospheric Administration (NOAA)'s Marine Debris Program estimates that it would take 67 ships a year to clean up less than 1% of the North Pacific Ocean, there are a number of ocean cleanup efforts which could change the scenario.
12. **Boycott microbeads:** Various little plastic scrubbers found in daily beauty products-facial scrubs, toothpaste, body washes-their tiny size allows them to slip through water-treatment plants. So, we should opt for products with natural exfoliants, like oatmeal or salt, instead.
13. **3D-Printing Recycled Plastic:** ReDeTec has developed a system that can convert plastic wastes into a completely new filament and then use it to print new objects. The printer known as ProtoCycler can be filled with a variety of plastic items like rejected 3D-printer models and bottles where it grinds them into small pieces before melting and releasing spools of plastic filament for use on the next project.
14. **Policies:** Taxes can also be used as a way to discourage specific ways of plastic management. For example, the creation of landfill tax makes people prefer recycling plastics rather than land filling them.

15. **Get Used to Not Using Disposable Plastics:** This is the easiest way to eliminate the use of plastic in the near future. Interestingly, nations like Kenya and France are restricting single-use plastic bag by banning its products. Violations with these products are heavily penalized.
16. **NASA Satellite Technology:** Concentrations of ocean plastic can now be detected by NASA satellite technology that was created in 2016. This ground-breaking research method can be fundamental in tracking and managing ocean plastic debris and one of many crucial scientific solutions to plastic pollution.
17. **Magnetic Coils:** Scientists have created a magnetic coil that is able to target microplastics in the ocean. This nanotechnology is able to break down microplastic in the water without causing any harm to marine life. It is thinner than a human hair, these coils are coated in nitrogen and a magnetic metal called manganese. When they react with oxygen molecules, they attack plastic and can help to break it down.
18. **Product Standards:** Product standards, certifications and labeling requirements can be made to educate the public regarding the environmental impacts of plastic, and on the health and safety hazards involved in their production and use.
19. **Awareness and Training:** Teaching students and making them practice good disposal techniques from childhood will make them responsible and good citizens. Embedding these practices at school level will help them once and for all as they will teach their peers and children. Institutions can provide education to individuals and businesses about the other alternatives they can shift to for bagging, storing and packaging various items.

Conclusion

Plastics are robust, designed to last for years without slightest deterioration in quality and property. To solve its pollution problem we must redirect its usage for multiple times. Currently, over 300 million tons of plastic are produced worldwide annually with more than half of it used just once and thrown away. Statistics show that only 9 percent of plastic gets recycled while 12 percent incinerated. Every year, 1.1 to 8.8 million tones of plastic waste is predicted to reach the ocean from coastal areas. The problem has only worsened during the COVID-19 pandemic due to the necessary increase of single-use plastics for personal protective equipment (PPE) like face masks and shields, some governments and businesses have delayed plastic bags and packaging bans. Prior to the COVID-19pandemic, World Resources Institute (WRI) andThe United Nations Environment Programme (UNEP) found that more than 100 countries regulated single-use plastic bags. The corona virus pandemic has revealed the importance of the short-term use of plastic to curb outbreaks or pandemic situations and help us feel safe. But there is no time to have a slow reckoning on the long-term issue of plastic waste. We need increased ambition, techniques and innovation by governments, companies and civil society, as well as the thoughtful adoption of a variety of preventative policy and legislative measures to address the scale of the problem for a better future. But all hope is not lost, and it is certainly not too late. While there are ways in which we can reduce the use of plastic in our daily activity, science and technology have allowed us to push the boundaries of what we thought was impossible.

NOVEL BIOLOGICAL TOOLS FOR SOLUTION TO PLASTIC POLLUTION

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Introduction:

The term 'plastic' is pretty generic. These are synthetic long-chain polymeric materials, extensively used in day-to-day activities. Due to light weight, corrosion resistance, strong plasticity & flexibility, thermal & electrical insulation and low cost, plastic items have become inevitable from use by humans. Plastic is made from organic polymers such as: polyethylene, polystyrene, polyvinyl chloride, polypropylene, polyethylene terephthalate etc. The polymers are synthesized from petroleum products, natural gas, coal, plants, etc. whilst biobased plastics come from renewable products such as carbohydrates, starch, vegetable fats & oils and bacterial biomolecules. Because of improper management and disposal practice, a large amount of plastic waste enters the environment through various pathways and cause serious environmental pollution problems. There are essentially three fates for plastics after use: recycling; incineration and discarding. Globally, it is estimated that only 10% of plastics are recycled, 14% incinerated and the remaining 76% goes to landfills or enters the natural environment. Plastic fragments, when less than 5 mm are referred to as microplastics and nano plastics are less than 100nm. When introduced into natural environments, plastics can be transported from land to river, and eventually reach the ocean. During the migration, plastics can lead to detrimental impacts on natural surroundings, wildlife, and even human health.

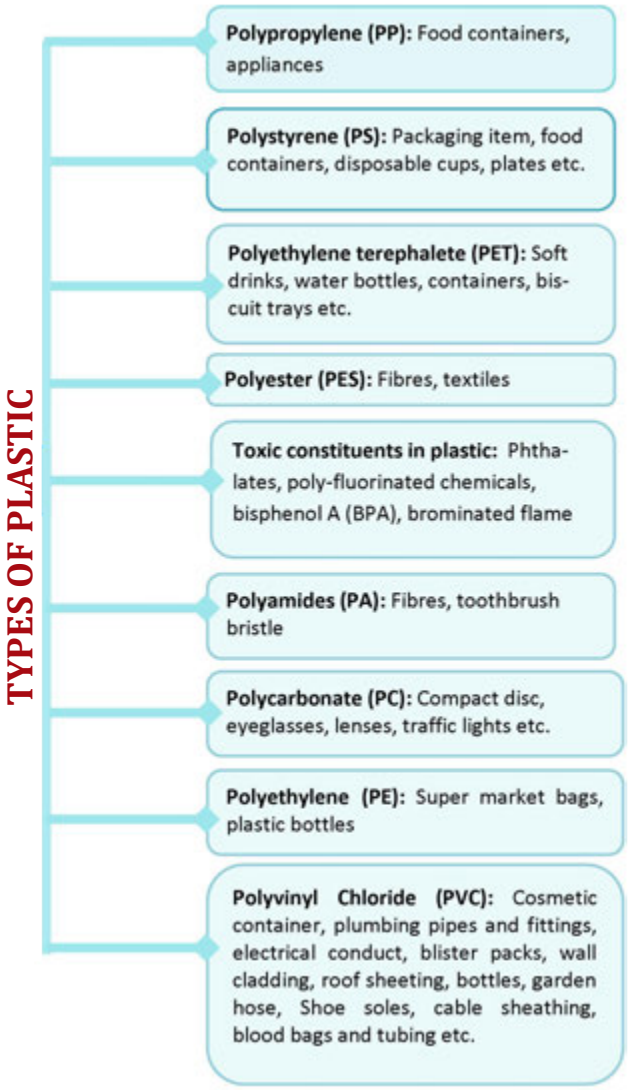

Figure-1: Types of plastics.

Plastic pollution is generated by the unsustainable use and disposal of plastic products in modern society which lead to threatened economies, ecosystems, and human health. Current clean-up

strategies have attempted to mitigate the negative effects of plastic pollution but are unable to compete with increasing quantities of plastic entering the environment. Mostly, the plastic wastes are managed by landfilling and burning either of which is detrimental to the natural environment. However, there are other biological means which can adopted for sustainable degradation and trapping of harmful plastic molecules and can be prevented from entering them into the ecosystem and food chain. This article highlights on various biological tools and alternatives to minimize the harmful effects of plastics and their components.

Harmful effects of Plastic and Plastic Pollutants:

Plastic waste incineration releases several pollutants into the atmosphere and is considered as one of the main sources of air pollution nowadays. The main pollutants released through incineration include particulate matters (PMs), metals, aldehyde (-CHO), methane (CH_4), nitrogen oxides (NOx), carbon monoxide (CO), carbon dioxide (CO_2), furan (C_4H_4O), polyaromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and other substances such as solid material (i.e., ash, as residue) which increases the levels of heavy metals, inorganic salts and organic compounds in the environment.

Effects on Environment: Accumulation of plastic wastes is now recognized widely to be a major environmental burden. Particularly in the aquatic environment where there is prolong biophysical breakdown of plastics and detrimental negative effects on aquatic wildlife. Most animals in the oceans mistaking plastic wastes dumped in the ocean for food, thereby ingesting them. Marine pollution by plastic wastes majorly affects sea turtles and other species whose main food are jelly fishes because they often confuse discarded plastic bags for jelly fish. The effect of plastic wastes on marine organisms, humans and the environment at large scale is of public concern and calls for the need to salvage the ecosystems and lives therein.

Effects on Human beings: Plastics have several toxic constituents like phthalates, poly-fluorinated chemicals, bisphenol A (BPA), Acetaldehyde, brominated flame retardants and antimony trioxide which can cause adverse effects on public health. Human consumption of animals exposed to microplastics and plastic additives can be detrimental.

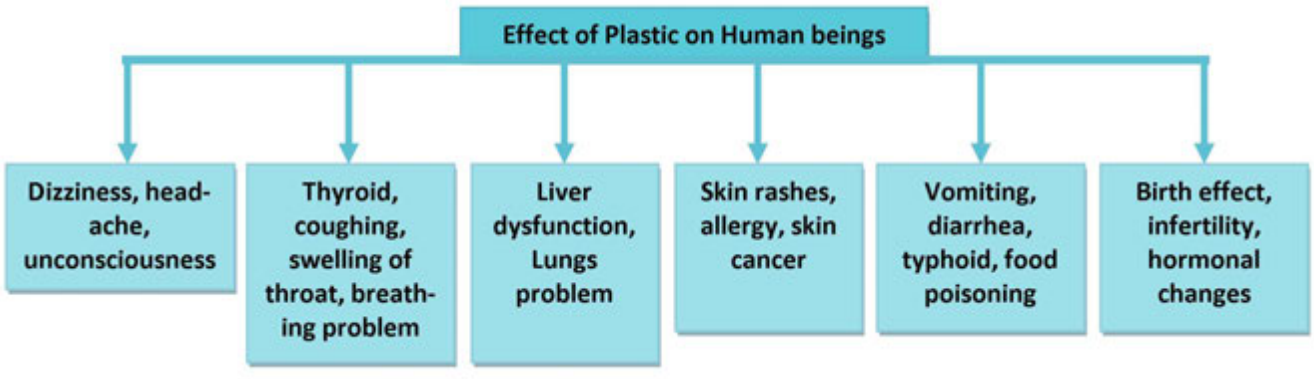

Figure-2: Harmful effects of plastics and their components on human health.

Biological tools for plastic degradation: The physicochemical properties of plastic play an important role in the degradation process. These degradation processes drive fragmentation of plastic debris into smaller and smaller items, including microplastics (MP) and nanoplastics (NP). Fragmentation is facilitated by a combination of changes in physicochemical properties that weaken the bulk polymer material. Plastic susceptibility to abiotic and biotic degradation depends on backbone composition and chain length, with long carbon chain such as PP, making polymers resistant to degradation. Abiotic degradation of plastic occurs naturally, as in case of mechanical degradation caused by the tidal forces, waves and abrasion by stones. This fragmentation process causes the formation of plastic debris, has been a threat to the planet. To overcome these problems, scientists have experimented various plants, microorganisms, microbial enzymes insects, etc. to make the process to a high degree of degradability. Both processes depend on particle characteristics such as size and charge.

Biodegradation of Plastics by plants: Various species of plants and macrophytes can absorb or internalize plastic particles. Both processes depend on particle characteristics such as size and charge, as well as plant features including a sticky or hydrophobic surface layer. Also, a range of stress responses have been observed for many plants and macrophyte species after both short and long-

Potamogeton illinoensis

Eichhornia crassipes (Bilatidala)

Panicum virgatum

Portulaca oleracea

Figure-3: Various plant species having potential for plastic degradation and removal.

term exposures to plastic particles. Many researchers have identified the potential of aquatic plants like *Azolla filiculoides* (water velvet), *Potamogeton illinoensis* (Illinois pondweed), *Lemna* species (duckweed), *Spirogyra* (algae), terrestrial plants like *Portulaca oleracea* (common purslane), *Dracaena sanderiana* (lucky bamboo), *Vicia faba* (broad bean), Switchgrass (*Panicum virgatum*) even Asian rice (*Oryza sativa*), for the safe degradation and removal of Bisphenol A (BPA) from the contaminated environment. BPA is a potent endocrine disrupting compound which is used in manufacturing of many important products like polycarbonate plastics, epoxy resins, flame retardants, food–drink packaging coating, and other. Other plants like *Eichhornia crassipes* and *Typha capensis* were evaluated by scientists for their capability to remove total dissolved solids (TDS) from a plastic recycling industrial effluent where the later showed more capability to remove undiluted effluent. Some of these plants are considered as weeds and are very common which can be observed around human habitations. Plants like *Eichhornia crassipes* are considered as invasive also and they can reduce the dissolved oxygen and can increase Biochemical Oxygen Demand of an aquatic ecosystem. However, these groups of plants may be exploited judiciously and scientifically for the degradation and removal of plastic molecules.

Biodegradation by microorganisms: Microorganisms are ubiquitous and play important roles in soil, agriculture, human & animal health and in environment. They have wide adaptability, have faster growth rate and survive in the environment by producing a range of bioactive chemical compounds like degrading enzymes, hormones, secondary metabolites, etc.

Microorganisms like bacteria, fungi and algae through their faster metabolic activities, help to degrade various polymer materials and synthetic plastics, including PES, polyvinyl, polyamide (PA) and PU, which represent the most widely used materials around the globe. Researchers have isolated potential microorganisms from different types of soils like garden soil, forest soil, garbage soil, mangrove soil, soil containing agricultural PE films for soil mulching, solid waste dumps sites, or landfill areas (municipal solid soil), waste water or sewage sludge, and even from Waxworm larvae for PE degradation. Microbial adhesion to the polymer surface is performed by the production of various proteins and polysaccharides which infiltrate into the material pores leading to an alteration in pores' size. During this stage, surface degradation occurs that alters the physicochemical properties of the plastic polymer.

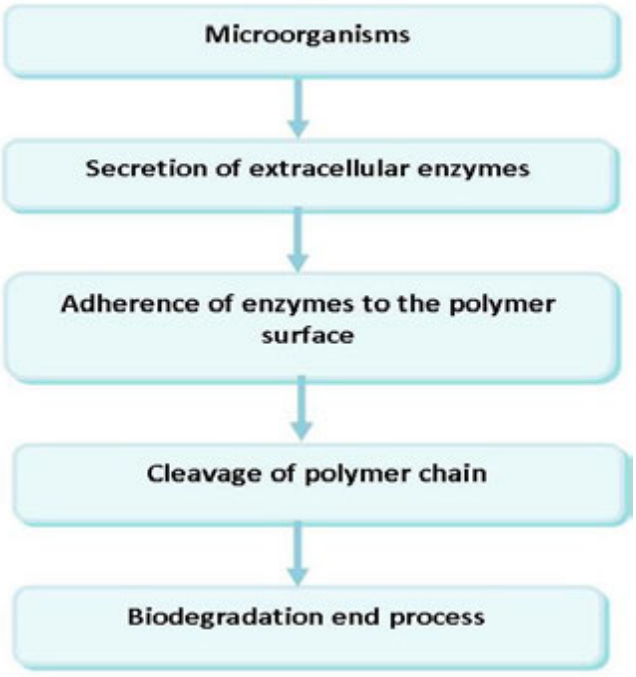

Figure-4:
Microbial mechanism for plastic degradation

Among the best bio-degraders for natural and synthetic polymers, there are several mesophilic bacterial species like *Pseudomonas, Arthrobacter, Corynebacterium, Bacillus, Rhodococcus, Micrococcus, and Streptomyces* having potential to degrade the PET which is used mostly for preparing water bottles, household containers, etc. Single species biofilms of *Klebsiella pneumoniae* and *Rhodococcus* successfully promoted the degradation of PE, where biofilms of *Pseudomonas citronellolis* and *Bacillus flexus* showed degradation activity towards PVC. Similarly, *Bacillus subtilis* ET18 and *Bacillus cereus* ET30 each could form single species biofilm on nylon and PET, causing damage to the plastic surface. Combinations of the two species of bacteria have been shown to enhance plastic-biodegradation process.

The sources of plastic-degrading enzymes can be found in microorganisms from various environments. Microorganisms that produce enzymes mostly belonging to two main classes, namely hydrolases and oxidases, and could be esterases, proteases, cutinases, dehydrogenases, or laccases. *Penicillium citrinum* Serine proteases and protease cocktails showed degrading activity towards PET. *Penicillium simplicissimum* also observed for degrading PE under laboratory condition. Slow PE degradation was also recorded by the bacterium *Nocardia asteroides*. High efficiency in PET degradation was demonstrated by the aromatic polyesterase synthesized by *Ideonella sakaiensis* 201-F6.

Table-1: Microorganisms and their plastic degrading enzymes.

Sl. No.	Enzymes	Microorganism	Target Plastic	Plastic items
1	Laccase	*Rhodococcus ruber*	PE and PP	Food container, plastic bottle, market bag etc.
2	Peroxidase (Lignin/ Manganese)	*Trichoderma harzianum/ Phanerocheate chrysosporium*	PE and Nylon	Food container, plastic bottle, market bag etc.
3	Polyesterase	*Moraxella* sp.	PET	Container, Plastic bottle
4	Cutinase	*Moniliophthora roreri/ Cryptococcus sp.*	PET	Container, Plastic bottle

Certain fungal species like *Aspergillus niger* and bacteria such as *Pseudomonas* and *Vibrio* reported to have biodegradation activity of PP. *Fusarium sporotrichioides*, *Fusarium moniliforme*, *Aspergillus terreus* and *Aspergillus nidulans other examples of degrading plastic to some extent*. The green alga *Monoraphidium braunii*, known for rapid growth and good tolerance to different natural organic matter (NOM) qualities, has shown the ability to tolerate and remove the endocrine disruptor bisphenol A. An isolate of *Aspergillus tubingensis* could degrade polyurethane films; the white-rot *Pleurotus ostreatus* and the ascomycete *Penicillium simplicissimum* have been found to degrade polyethylene.

From the above discussion, it could be observed that microorganisms can be used as direct tools for degradation and removal of various plastics and components from environment. However, these biological tools need to be used very meticulously to avoid non-target achievements.

Degradation of plastics by Insects:

It is very interesting to note that many insect species also degrade plastics by their salivary enzymes and with assistance of their oral microflora. They can play vital role in the future for an innovative approach for plastic waste management. Insect species like Waxworms (*Plodia interpunctella*) having bacteria in their guts, capable of degrading PE by chewing and eating PE films are *Enterobacter asburiae* YT1 and *Bacillus* sp. YP1. Others include superworms (*Zophobas atratus*), mealworm (*Tenebrio molitor*) and wood-feeding termite (*Reticulitermes chinensis*), the greater wax moth (*Galleria mellonella*), land snail (*Achatina fulica*). Research findings indicated that PE biodegradation depended on the activity of microorganisms present in the gut of the larvae. Other insects or invertebrates such as enchytraeids (*Enchytraeus crypticus*), isopods (*Porcellio scaber*), oribatid mites (*Oppia nitens*) and springtails (*Folsomia candida*), have also been found to degrade and digest short fiber PE. The degradation activity of the cigarette beetle (*Lasioderma serricorne*), the rice weevil (*Sitophilus oryzae*) and lesser grain borer (*Rhyzopertha dominica*) on packaging and multilayer films of PP, PE, and PES have also been investigated.

Figure-5: Insect species having capability of plastic degradation.

Biological Alternative:

Plastics can be manufactured from bio-based or fossil-based materials and can be biodegradable or non-biodegradable. While bioplastics are only made from renewable materials, biodegradable plastics are made from fossil based or are made with mixture of renewable and fossil-based materials. Biodegradable plastics are those that can be completely degraded in landfills, composters or sewage treatment plants by the action of naturally occurring micro-organisms.

Use of Biopolymers:

Biopolymers are natural alternatives for synthetic polymers which can be obtained from natural sources and represent themselves as sustainable solution for nondegradable plastic. Biopolymers such as starch, cellulose, pectin, keratin, chitin, gelatin, Polylactic acid and polyhydroxyalkanoates

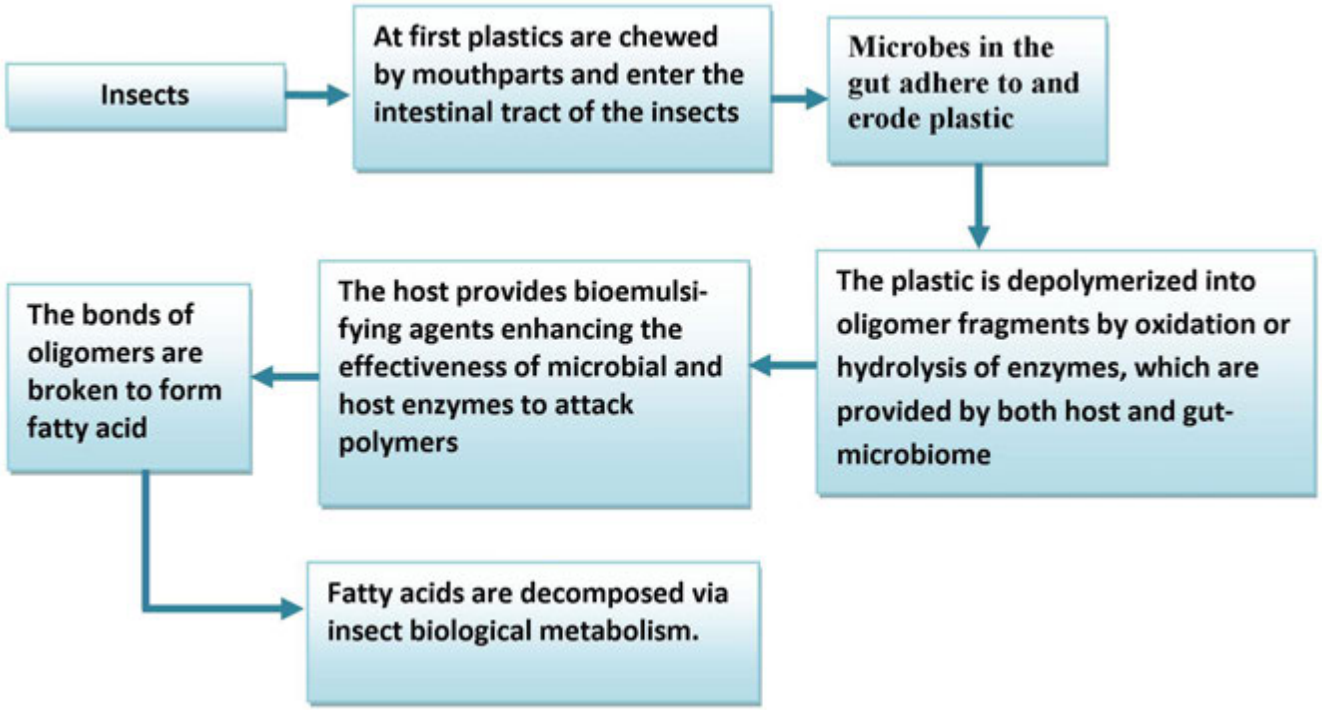

Figure-6: Mechanism of plastic degradation by insects

can be obtained from natural biomass sources. All these biopolymers exhibit suitable physiochemical, thermal and mechanical properties that make them suitable for the production of bioplastics that are biobased and biodegradable in nature. Bioplastics is a plastic produced from cellulose that is made of wood pulp by a British chemist in the 1850s first. Both cellulose and starch are not plastic but can be transformed into plastics by polymer technology or fermentation; by using various techniques like casting, mixing, extrusion, injection molding etc. Bio-ethylene and Biopropylene have the prefix "bio", indicating that they are made from renewable materials, and have identical properties to that of petrochemical based plastics.

Now, bioplastics can be produced from different materials including weeds, hemp, plant oil, potato starch, cellulose, corn starch, etc. Sugar-based bioplastics can biodegrade under normal conditions for composting. Biodegradable shopping bags are made of polymers that degrade, or decompose, when exposed to air, water, or sunlight. In the present trend, blending of starch is done with other bio-polymers like polylactic acid, polycaprolactone or polybutyleneadipate terephthalate to prepare bio-plastics. Scientists have now shown that the infamous weed 'Water hyacinth' is a rich source of carbohydrate and can be used to make biodegradable plastic. Water hyacinth derived sugar molecules like lignin, cellulose and hemicelluloses can be converted into polyhydroxy butyrate (PHB), a polymer that is a raw material for making biodegradable plastic.

Microbial biopolymers such as extracellular polymeric substances (EPS), polyhydroxyalkanoates (PHAs), xanthan, welan, succinoglucan, curdlan, chitosan produced by a broad range of microbial taxa have potential for use as an alternative of plastics. Research programmes need to be intensified to utilize these tiny organisms for production of bioplastics for betterment of the environment.

Other steps to mitigate plastic pollution:

Public awareness on the harmful effects of health: Efforts must be made to educate the general populace on the potential environmental and public health effect of pollution by plastic wastes. This will go a long way to reduce the pollution rate and preserve the quality of the environment. There is need for people to be aware of the chemical constituents of plastic products and their health effects. Educational curriculums at different levels must include ways of plastic pollution reduction and waste management systems as information resource.

Administrative guideline for single use plastic: Municipal or Government authorities and NGOs may play crucial role in recognizing and legitimizing both plastic waste recovery and trading activities and equipping them with state of art designs of waste management technology and system. The Municipal authority should be responsible for setting up, operationalization and coordination of the waste management system and for performing the associated functions. Documentary films should be prepared to aware the people. Plastic items should be recyclable or compostable. The real challenge is to improve plastic waste management systems.

Conclusion:

Plastic has become an inseparable part of human life and can't be avoided completely under the current scenario where number of developmental activities going on altogether. Hence, holistic and sustainable approaches are required to mitigate the harmful effects of plastics on environment and humans. That may create negative impact on the environment. For any type of pollution there is always a solution in the mother nature. As evident from the preceding discussions, various species of plants, insects and especially number of microorganisms can be used as invincible tools for the degradation and removal of various plastic molecules and their ingredients which have already contaminated the ecosystem. Further, various biomolecules and biopolymers from microbial and plant sources can be used as effective alternatives for preparation of ecofriendly bioplastics. It is not the job of the Government alone to minimize the effects of plastics by the implementation of laws and rules or to ban items; rather we all need to realize the harmful consequences that would happen by the biomagnification of plastics in the food chain and ecosystem. However, scientific research also needs to be intensified for the utilization of microbial agents for degradation and removal of contaminated plastics and use of plant fiber materials as alternatives.

BEAT PLASTIC POLLUTION:
SOLUTIONS TO PLASTIC POLLUTION

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Plastic pollution is a major challenge for people and the planet. Find out the best ways individuals, groups and governments can tackle plastic pollution, clean up the world's cities and help stop ocean plastic. Plastic is incredibly useful and convenient, but it also causes pollution that damages health and the environment. In some parts of the world, formal waste disposal services aren't coping with the amount of waste being created. This is the case in Bangladesh, where Practical Action is working with informal waste workers, local NGOs and the Government to find solutions to the waste crisis. Insufficient waste management means that plastic, including recyclable plastic, is dumped on open ground and in rivers. Plastic in rivers can block water channels and pollute sources of fresh water. Burning plastic releases toxic gasses that can cause illness. Plastic waste in landfill releases carbon dioxide and other greenhouse gasses, including methane, which contribute to the climate crisis. A lot of plastic waste ends up in the sea. Plastic in the ocean harms marine life and becomes part of the food chain. Around the world, solutions are being developed to fight plastic pollution. Learn about the solutions that are already making a difference in Bangladesh and around the world, and find out the small steps we can take to reduce plastic waste in our own life.

Solutions

There are ways you can reduce plastic consumption in your own household:

1. Consider cooking using raw ingredients if you can–it cuts down on both packaging and food waste.
2. Avoid unnecessary packaging by buying from shops that use paper bags instead of plastic ones. Even better, shop at 'scoop shops', which avoid packaging altogether.
3. Glass is another potential alternative to plastic. How about getting our milk delivered in retro glass bottles by a traditional milk delivery service?
4. Did you know that some teabags contain plastic? Look out for compostable varieties, or switch to loose-leaf tea to avoid this.
5. Keep old water and juice bottles and use them to water your plants.
6. Save plastic jars and pots and use them to store small household items.
7. Use old salad dressing containers to mix and store your own homemade condiments.
8. Cut off the bottom of large plastic bottles and use them as small planters or seed pots.

9. Recycling plastic into new products. Take positive action and recycle more plastic in your own household:
   a) When you're at the supermarket, look for products that use biodegradable packaging rather than plastic.
   b) Make sure you're recycling everything you can – check you local recycling service's website for a full list of what can be put in your recycling bin.
   c) Sign up to the Marine Conservation Society's Plastic Challenge for a fun way to help your family monitor their recycling habits.
   d) Use your consumer voice by calling out shops that use excessive packaging and encouraging food retailers to provide reusable containers.

10. NASA Satellite Technology-

    NASA's Cyclone Global Navigation Satellite System, also known as CYGNSS, was originally created to predict hurricanes by monitoring tropical wind speed over the ocean. Scientists discovered that this technology can detect the concentration of microplastic in the water by measuring the surface of the water. It will also provide a huge contribution to further research on the effects of microplastic on the ecosystem, help non-profit and private organizations clean up the sea, and protect aquatic life.

11. The Plastic-eating Enzyme-

    One of the most important scientific solutions to plastic pollution that have emerged is the plastic-eating enzyme. In Japan 2016, a scientist discovered a plastic-eating enzyme that was capable of breaking down Polyethylene terephthalate (PET) – the most commonly used type of plastic. This enzyme, known as Ideonella Sakaiensis 201-F6, is a bacteria that can digest plastic by secreting an enzyme called PETase, and ingesting the carbon in PET to be used as a food source. Though the breakdown process remains to be relatively slow, scientists have been working to speed it up. An international team of scientists have been able to modify the molecular composition of the enzyme, and tweak it to consume PET 20% faster than it originally did.

12. Plastic-eating Mushrooms

    A darkly pigmented species of fungus, known as Aspergillus Tubingensis, has been found to contain agents that can degrade polyurethane (PU). Samantha Jenkins, lead biotech engineer for bio-manufacturing firm Biohm was studying different types of fungus in a research project, when she came across the plastic-eating fungus and found the fungus had eaten its way through the plastic sponge that was used to seal it. PU plastic and discovered the fungus to populate as it consumes more plastic, potentially creating a new source of biomaterial "for food, or feed stocks for animals, or antibiotics"

13. Converting to Fuel

Australian company Licella Holdings has developed a new patented technology, known as the Catalytic Hydrothermal Reactor (Cat-HTR), that can convert unrecyclable plastic into oil, it has been able to melt plastic and convert it into liquid fuel. Through a process similar to a commercial-sized pressure-cooker, it reduces plastic to its component parts, producing a range of materials including oils, waxes and plastics that can be turned into other plastic products or fuels.

14. Converting to Roads

One of the many scientific solutions to plastic pollution is to convert waste into roads. A project known as Plastic Road, created a bike path in the Dutch city of Zwolle and a road in Overjissel in 2018 using 70% recycled plastic. The plan is to increase this to 100%. The project has been proven successful as plastic is more durable than asphalt and requires less heavy equipment and time to install, which makes its carbon footprint smaller. Plastic Road intends to carry on designing, creating and supplying these sustainable, climate-proof and circular roads, made from municipal plastic waste and "with the smallest possible negative impact on our planet and natural resources."

15. Substitute with Seaweed

One of the most significant scientific solutions to plastic pollution to emerge in recent years is bioplastic. A plastic alternative comprised of materials produced from renewable biomass sources. Indonesian start-up company Evoware has been researching ways of converting seaweed into a bioplastic. They work with local seaweed farmers to create a range of different types of packaging such as sandwich wraps, burger wraps, sachets for spices, and soap, which can be dissolved in hot water, and in some cases, edible. Indonesia produces 10 million tonnes of seaweed each year and could reach up to 19 million tonnes by 2020, which could help supply Evoware's expanding efforts.

16. Get Used to Not Using Disposable Plastics

About ninety percent of the plastic products used every day are used once and then thrown: plastic wrap, grocery bags, straws, disposable cutlery, coffee-cup lids among others. Consider how you often depend on these items and change to reusable versions.

This is the most obvious and easiest way to eliminate the use of plastic in the future. Interestingly, nations like Kenya and France are phasing out single-use plastic bag by banning its products. Infractions with these products are heavily penalized and could send you to jail.

17. Avoid Using Bottled Water

People are advised to drink a lot of water, at least 8-ounce glasses every day. Many who stay outdoors throughout the day keep themselves hydrated using plastic water bottles, which are thrown to trash after use.

18. Institutional Arrangements and Creation of Awareness

States can use their power and authority to control plastic pollution by forming various institutions that can manage and protect the ecosystems. For example, the Canadian federal government established an institution to safeguard marine areas. In addition, these institutions can provide education to individuals and businesses about the alternatives they can shift to for bagging, storing and packaging. Put simply, people will be aware of the causes and effects of plastic pollution and how to prevent it.

19. Collection of Plastic-

This is done to limit the scattering of plastic waste in the environment. It can be done through the curbside collection, where people place used plastics in a special container to be collected by a private or public hauling company.

People can alternatively use drop-off recycling centers, where they take their plastic wastes to a centrally placed facility. Once collected, the wastes are taken to the factory for recycling. In the United States, more than 80 percent have access to these collection centers.

20. Fungus That Eats Plastic-

An unimaginable amount of plastic has been dropped into the environment over the years, and once there, many centuries will pass before it degrades. Even as above mentioned, remains of microplastic may continue to exist unnoticed.

But recently, scientists discovered Aspergillus Tubingensis, a plastic eating fungus that lives in the soil. It secretes enzymes which help to break down the polymer chains that hold plastic together.

21. Reuse of Plastic Waste

While the main objective of the world is to totally eliminate plastic items in the environment, it is also necessary to ensure that the existing ones are managed properly.

Individuals can enhance this by keeping safe the plastic bags they use at one time and go back with them to the shop.

22. Mushroom Packaging

Science is always good at identifying a problem and providing a solution to it no matter how long it takes. With this new discovery, the future of plastic packaging is at stake. It introduces the world to biodegradable packaging.

Mushroom packaging is fire resistant and can be molded to any shape easily. It is composed of an extensive connection of thread-like roots called mycelium. Scientists have perfected this packaging and are currently making structures with it.

After use, it can be thrown away where it naturally decomposes.

ALTERNATIVIVE USE OF **PLASTICS**

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According to researchers from the inter governmental panel on climate change, plastic production and disposal resulted in 850 million tons of green house gas emissions. Plastic contains toxic chemicals, which can increase the chance of disease and affect reproduction. Plastic sticks around in the environment for ages, threatening wildlife and spreading toxins. Endocrine disruptors like bisphenol will increase our risk of certain concerns and even increase risk of infertility and birth defects.

Alternative Use of Plastic

"Handle with care, Plastic is everywhere"

"Go Green, Plastic is obsence"

1. **Cloth Dipers:** Cloth dipers are the best option for babies as they are soft and comfortable.
2. **Reusable Shopping Bags:** Keeping a cloth or paper bag in handly while going to the grocery store can contribute to the overall empowerment of an ecofriendly environment.
3. **Menstrual Cups:** Sanitary napkins are plastic products the amount of these napkins used by all the women is unimaginable and highest contributer of plastics.
4. **Eco Friendly Tumblers:** Tumblers may have a silicon lid for plastic tops but they are still more environmentally friendly than cups made entirely of plastic.
5. **Stain Less Steel Bottles:** Steel bottles are highly durable and reusable and it reducing the disposal of plastic bottles.
6. **Use of Bamboo:** Toothbrushes are disposal items that must be replaced every months. It takes around 400 years for decompose and burning them is not an option as they relase toxic chemicals. Use of bamboo tooth brush can save too much plastics.
7. **Compostable garbage bags:** They are the best alternative for plastic bags.
8. **Eco friendly cutlery:** Wooden spoons and other ecofriendly cutlery are the best alternative of plastics.
9. **Bamboo Cups and Plates:** They are another option for eco-friendly disposable products.
10. **Reusable Straws:** Now paper straws have become popular options.
11. **Bee Wax Wraps:** Bee Wax warps are an alternative to plastic bags cling wraps.
12. **Edible Beer six pack rings:** Six pack rings that are 100 percent biodegradable and edible. This ring can actually be eaten by fish without harming them.

13. **Oyster Shapes Cases for homemade Soaps:** Palm leaves from area palm to create cases for their soaps.
14. **Edible water bottles:** This is used to provide water in a container without harming the environment.
15. **Paper Bottles:** The outer part of the bottle is compostable and water resistant.

"Less Plastic, clean earth healthy

Animal and human"

16. **Use of "3R" and Refuse for plastics:**

Recycle – use Recycle Plastics

Reuse – Reuse Plastics

Reduce – Reduce use of plastics.

17. **Awareness about the effect of use of Plastic: "**Awareness is better than cure" The people should aware about the bad effect of plastic they are using in their daily life.
18. **Use of bioplastics:** As we want to see our future without plastic waste through sustainability, then there is a need to use bioplastics which are not harmful.

Reducing the use of plastic is important because plastic production requires an enormous amount of energy and resources. This causes carbon emissions and contributes to global warming. Recycling plastic is not efficiednt – only 9% of plastic ever produced has been recycled.

Go back to nature: Various products made from the coconut coir are coir yarn, mats, rod mats, buckets pith, rope, brushes can reduce use of plastics. Natural fibre cloth-sustainable cloth can made from organic wool, hemp or bamboo.

Wood: A renewable resource, wood from sustainably managed forests can replace plastics like brushes, kitchen utensils and cutting boards.

Paper: Many things where packaged in plain paper which batter than plastics.

Conclusion: Plastic pollution is a widespread problem affecting the marine environment. It threatens ocean health the health of marine species, food safety and quality, human health, coastal turism and contributes to climate change. There are many ways to stop plastics. "Wean yourself off disposals plastics", "Buy in Bulk", "Purchase item second hand"

The more we manufacture and use plastic the more it gets dumped, adversely affecting human life, wild life and plants. Then it need for sustainability and circularity. Today we need to use alternative than plastics which does not have to destroyed, but that should be used again and again.

DON'T BE DRASTIC
SAY "NO" TO PLASTIC

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In our platic filled world avoiding plastic is pretty challenging. But finding alternative to common items like plastic bottles, plastic packaging is becoming increasingly easier and out a moment too soon for our plastic chocked planet. This versatile material is found everywhere in our house as it is cheap, durable easily available, light in weight etc. Items like food packages, milk packets, personal care products, synthetic fabrics, Baby wipe and Disapers, wrapping paper, cigarette filters, coffee & tea cups etc. to name a few. We should be Eco-friendly, break the plastic habit and cut down plastic pollution by using Alternative of plastics. There are main things which are to be considered and the citizens should be made aware of. The long lasting plastic alternatives available right now are.

1. **Natural Fibers:** Natural cloth and jute bags can replace plastic bags. Sustainable clothing made from organic cotton, wool, hemp, bamboo can be used. People should inculate the habit of carrying a cotton or jute bag to market as it was done in earlier time when use of plastic bags were not prevalent.
2. **Stainless Steel:** It is tough, easy to clean, reusable. It is the best option now a day for reusable food and beverage storage. We can replace single use cups with steel cups. Nearly 500 billion disposable cups are consumed every year.
3. **Glass:** Instead of using disposable cups glass cups can be used as it is a reusable alternative. Food can be stored in glass jars. Examples are jam, honey, pickles, butter, oil, homemade drinks etc.
4. **Platinum Silicone:** It is made of sand, food grade platinum silicone is flexible & durable. It is heat tolerant. We should look for silicone products without plastic fillers for baking and cooking.
5. **Wood:** We should use wooden cutting boards instead of plastic cutting boards. Handles of knife, cutter, screw drivers etc. can be made of wood.
6. **Bamboo:** Use of Bamboo toothbrush instead of plastic toothbrush. Instead of plastic baskets we can use bamboo baskets, bamboo pots, bags etc.
7. **Pottery:** Clay pots and utensils can be used they are ecofriendly.
8. **Ceramic:** We can use cutlery of ceramics instead of plastic. It is reusable.
9. **Say "NO":** to liquid soaps, Shampoo, liquid detergents. We should switch to non-liquid soaps. We should use soap bars and use naturally available shampoo.

10. **Use of Natural:** Sponge or wooden brush instead of plastic sponge and scrubber.
11. **Say "NO":** to polyster carpet. Instead use cotton, jute or woolen carpet.
12. **Use of our own home made cleaners:** Using baking soda or a kitchen stone for tough cleaning.
13. **For clothing, bedding and Towels:** Choose only cotton, hemp, woolen, bamboo materials.
14. **Plastic Cotton Buds / Swabs:** Instead of using plastic we can use bamboo stick cotton Buds & Swabs. Now due to corona (COVID-19) swabs are used for testing. Ecofriendly bamboo swabs can be used. An average person disposes 415 buds a year. They end up in the ocean. Instead fluid ear washes or bamboo buds should be used.
15. **Bioplastics:** Bioplastics are biodegradable but they don't breakdown in home compost land fills or loose in the environment (Plant based plastic, Hemp Plastic etc.)

Natural alternative packaging can be done by the methods which are already in use.

1. Pressed hay is used as egg cartoons in Poland.
2. Seaweed based packaging is edible & biodegradable.
3. Mushroom Package – A combination of agricultural waste and mushroom mycelium is grown on a hemp flour mixture and then dried to hall the growth on a hemp flour mixture and then dried to halt the growth process. It is used to replace syrofoam packaging.

Alternative use of plastic is necessary to decrease carbon emission and decrease global warming. As 9% is only recycled, 60% discarded in land fills& oceans.As it stays for thousands of year transforming into microplastic leaching into our water supplies & food. 4% of the worldspetroleum is used to make plastic. Form 1950-2012-Plastic production increased from 1.7 million tones to nearly 300 million tons/yr.

Something needs to change with our help. One step for a better environment today is one step towards a better future tomorrow. Let us lead the way to a plastic free future for our kids. So eliminate plastic from your life.

"STAY AWAY FROM USE & THROW" PLASTIC,

"DON'T LAMINATE THE EARTH".

PLASTICS IN DAILY LIFE AND ITS ALTERNATIVES

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The use of Plastic has become a very essential material in our day to day life and plays a vital role in human comfort. But due to the non-biodegradable property of plastic, it has become a major pollution concern throughout the world.

Definition of Plastic

Plastics are a group of materials, either synthetic or naturally occurring, that may be shaped when so9 and then hardened to retain the given shape. Plastics are polymers. A polymer is a substance made of many repeating units. The word *polymer* comes from two Greek words: *poly,* meaning *many,* and *meros,* meaning *parts* or *units.* A polymer can be thought of as a chain in which each link is the *"mer,"* or *monomer* (single unit). The chain is made by joining, or *polymerizing,* at least 1,000 links together. Polymerization can be demonstrated by making a chain using paper clips or by linking many strips of paper together to form a paper garland.

Plastic in our Life

Food packaging: Cereals, crackers, snacks, and many teas and coffees come in plastic. Most cheese, meat, and yogurt is packed in plastic, as are many condiments.

Milk cartons: Milk cartons (including soy and nut milk) Waxed cardboard contains approximately 20% plastic and 80% paper. Metal cans are often lined with plastic.

Personal care products: In addition to coming in plastic bottles and tubes, many shampoos, gels, creams, moisturizers, and make up contain synthetic polymers. Some may also contain microbeads. Dental floss and disposable razors are also often made from plastic base materials.

Synthetic fabrics: Polyester, nylon, rayon, and acrylic yarns and fabrics are all made from plastic. When washed, these materials shed millions of microscopic plastic fibers that eventually wind up in waterways.

Baby wipes and diapers: From their inner layer to their waterproof outer cover, disposable diapers are made from plastic super absorbent polymer makes up the absorbent inner core, while the outer layer is usually a petroleum-based plastic or a plastic-treated fabric. Feminine hygiene products:

	The average disposable sanitary napkin contains about two grams of plastic. Wrapping paper is often a mix of plant fibers and laminated plastic. Tape, glitter, and stickers also contain plastic.
Chewing gum:	Yes, even gum. One common ingredient included in the "gum base" listed gum labels is polyvinyl acetate.
Cigarette:	filters contain cellulose acetate, a form of plastic.
Glues:	Glues including school glue and wood glue, contain polyvinyl acetate, a type of plastic. The glues used to seal tea bags include polypropylene, another plastic.
Coffee cups:	Coffee cups even those that appear to be made from paper often have plastic in the lining.

The use of plastic products has increased significantly in the recent past, with many enterprises joining the industry and many more varieties of plastics being made. Firms consider plastics easier and cheaper to manufacture as compared to other materials - such as metals and stones - because they're produced from byproducts of crude oil and can be recycled. Consumers also consider plastics lighter, compared to other packaging materials. However, the wide use of plastic products has shortfalls. Harmful Nature.

Disposable plastics used in packaging foodstuff meant for human consumption contain harmful compounds. Improper disposal of these packaging products leads to these harmful compounds finding their way to water bodies, where they dissolve over a long time due to their non-biodegradable nature. Littered plastics are also harmful to animals because they occasionally eat them and die. Additionally, plastics fabrication involves the use of potentially dangerous chemicals, which are added as stabilizers or colorants. Most of these chemicals have not undergone an ecological risk appraisal, and their impact on human well-being and the environment is presently vague. One example is phthalates, which are used in the manufacture of PVC.

Environmental Degradation

Plastics are generally non-biodegradable; hence, they may take centuries to decay. This is due to the intermolecular bonds that constitute plastics, whose structure ensures that the plastics neither corrode nor decompose. Plastics disposed of indecently get washed away to water reservoirs. They clog waterways and float on reservoirs, polluting and making them unsightly. Low Melting Point

Plastics generally have a low melting point, so they can't be used where heat levels are high. This also means they cannot be used as protective barrier for furnaces. Some plastic products are highly flammable - polystyrene, acrylics, polyethylene and nylons commonly used in packaging, home and office appliances. This makes them a fire hazard.

Plastics generally have a short useful life compared to metals. This short life cycle results in pile-ups of unwanted garbage in the office, home or waste yards. Although some of the plastics are

recycled, most remain uncollected in dump sites and pollute the environment. Additionally, polythene bags are easily carried by wind, something that makes them almost impossible to collect for recycling.

Alternatives use of plastic.

Stainless steel

Tough and easy to clean, stainless steel options for reusable food and beverage storage have multiplied in recent years. You can replace single-use cups, kitchen storage, lunch boxes, and more with this durable metal.

Glass

While not biodegradable, glass is inert, inexpensive and infinitely recyclable. And since many food items come packaged in glass, upcycling glass jars into food storage is a no-cost way to give your food packaging new life. Jars from jam, honey, pickles, nut butters, and so much more can be added to your no-waste toolkit for shopping from the bulk bins. They can also be repurposed to store leftovers and homemade drinks, or decorated and turned into homemade gifts.

Platinum silicone

Made primarily of sand, food grade platinum silicone is flexible and durable. It's also heat tolerant, so you can boil, bake, and cook in these products without danger of denaturing. Look for silicone products without plastic fillers.

Beeswax-coated cloth

Used primarily as a replacement for plastic wrap and plastic bags, beeswax-coated fabric is easy to use and easy to clean. It also smells great.

Natural fiber cloth

Natural cloth can replace plastic bags. Sustainable clothing made from organic cotton, wool, hemp, or bamboo won't shed plastic fibers when washed. Felted or recycled wool is a versatile, safe, and compostable material for children's toys, household containers, and more.

Wood

A renewable resource, wood from sustainably-managed forests can replace plastic in household items like cleaning brushes, kitchen utensils, and cutting boards.

Bamboo

This fast-growing renewable resource can replace plastic in items like tableware and drinking straws. It is lightweight, durable, and compostable.

Pottery and Other Ceramics

Around for millennia, pottery and other fired ceramics offer a stable, waterproof alternative that's good for food storage and tableware. Look for non-toxic glazes.

Paper

In days gone by, many things were packaged in plain paper. And while better than plastic, paper can't be recycled infinitely because every time it's reused, the fibers get shorter, limiting its use. Luckily all paper except the glossy kind is safe to put in your home compost.

Cardboard

Cardboard is fully compostable at home as long as it's not coated in, you guessed it, plastic. Many companies are now packaging their products in plain cardboard to cut down on waste. You can also use cardboard boxes to replace storage containers in your home.

Keep in mind that anything you buy has an environmental footprint. Though longer lasting than plastic, things made from glass, metal, and so on still take energy to make and transport. For these swaps to make sense, you need to use them over and over and over again. Buying well-made, durable products will help ensure you get the most use from whatever you choose.

Conclusion

Plastic though considered as a wonder material has proved to be a real challenge in maintaining sustainable development indices. Complete and stepwise ban of plastic is mandatory across India and around the globe. Various socio-economic- political issues need to be addressed in order to maintain viability of the burning problem across a changing timescale. However, the situation has more worsened in recent times. It is high time to search for eco-friendly alternatives such as cotton, jute and other forest based materials that would intern help in sustainable forest management.

PLASTICS
AND ALTERNATIVES TO IT

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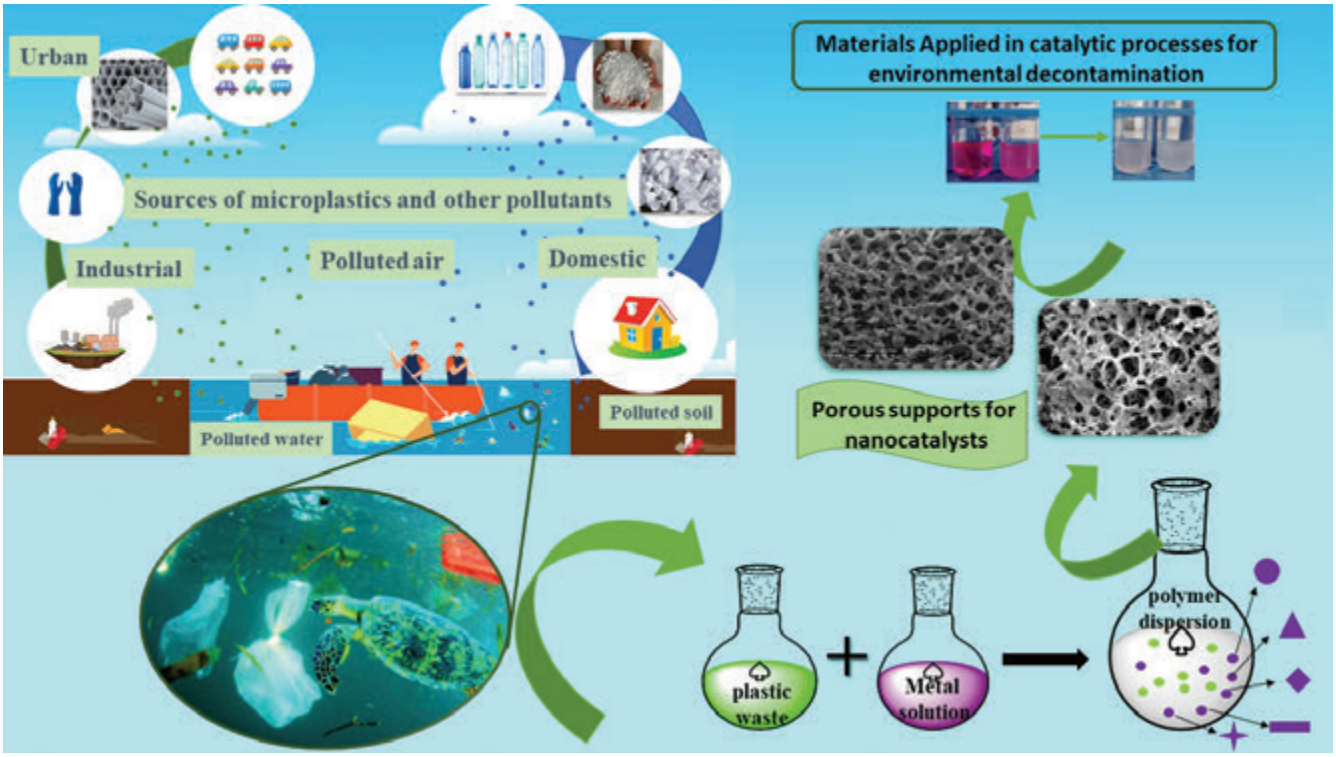
Plastic - the renowned material known for its sustainability, strength and design flexibility - has crept into every corner of man's life finding high use in different sectors ranging from healthcare and medicine, automotive, packaging, aerospace, building and construction and household activities. Considered as one of the greatest inventions, it was introduced by Alexander Parker in 1862. From the early 1900s, it slowly but steadily became the go-to household material through various developmental iterations in the form of Polymers, Polyethylene, Polystyrene, Bakelite, etc. Soon, it became more accessible to the common people and mass production and discovery of its utilities in other spheres of life made it the most popular material of choice to be used in a daily basis. The affordability of plastic gave way to its widespread in the simplest of use cases and its capability of holding liquid plus the additional flexibility only added up to the availability of plastic in various forms to dominate the transportation and storage sectors. And thus, it became an indispensable and irreplaceable part of our lives. Imagining life without plastic is impossible in this present scenario. From toothbrush to food wrappers, from carry bags to transport vehicles, medicine packets to medical utilities, plastic finds it its place everywhere. Luxury transformed into commodity. Activities like manufacturing and production revolve around plastic and its derivatives. And then it became a man's menace.

Extensive use of plastic turned out to be more dangerous than anyone had ever imagined. What was once considered as a revolutionary thing now has become a poison not only to man but also to its surroundings. Overuse of plastic made it deep-rooted into our culture and daily life because of which more problems in the long-term are imminent as a price for its usage. Indeed, plastic has been economically feasible for all sections of society but it takes a heavy toll on ecological balance.

Littering polythene bags here and there not only makes the surroundings look dirty but it acts as a breeding ground for numerous disease-causing organisms. Use and throw poly bags, refills of pens, plates, etc. cause overcrowding of landfills which results in decrease in dumping zones. Since, plastic is non-biodegradable, it is impossible for the disposed plastic materials to be ever decomposed as a result, the volume just keeps getting increased playing a big role in environmental pollution. The harmful constituents of plastic and plastic-derived products when taken up accidentally by animals and humans can prove to be fatal. Soil is polluted thereby reducing soil fertility and soil water holding capacity which deprives the plants from getting required nutrients and as a result of which crop production takes a huge hit. Large chunks may clog up drains and canals and cause flooding of areas.

When burnt, poisonous chemicals are released into the air and the residue is again a toxic product for all living beings. The production of plastic and plastic derived products itself goes through a process harmful for our surroundings. When it's used to store food, it can also react with it and render the food poisonous. According to a report by Central Pollution Control Board of India for the year 2018-19, 3.3 million metric tons of plastic waste were generated by Indians. Of all the plastic waste produced in world, 79% enters the environment and only 9% of plastic waste is recycled. Single use plastic is so cheap and convenient that is it has replaced all other materials from the packaging industry but it takes hundreds of years to disintegrate. Of the 9.46 million tons of plastic waste generated in India annually, 40% goes uncollected.



Mitigation with the bio hazards of plastic requires the age-old reuse, recycle and reduce mantra. It has to be incorporated in alternative uses also to check the over-dependency and subsequent plastic overcrowding in the environment. Plastic can be mixed in definite proportion with bitumen to make roads. These roads so produced are more durable and resist wear and tear for a longer period of time as compared to their conventional counterparts. Instead of single use plastic carry bags, poly bags for each purpose, cotton and jute bags should be encouraged. Not only this will reduce the amount of plastic but also help utilizing the remnants of fiber crops and thus serve as a dual benefit. Compostable trash bags that is made from potato starch can be used which can then be used to throw with waste materials. Food wrappers instead of being made primarily from plastic derivatives can be made from beeswax and parchment paper that are more eco-friendly options. Areca Palm tree is used by many Indian entrepreneurs to produce palm leaf packaging for food such as fruits, vegetables, and nuts and is biodegradable and can be used for food packaging. Considering that a

person is supposed to use a new toothbrush every three to four months, it's disheartening to think how much plastic waste we add to landfill sites from toothbrushes alone. Plant-based toothbrushes have been around for several years. All components, even the box and packaging, are made from bamboo or compostable castor bean nylon. Wood from sustainably-managed forests can replace plastic in household items like cleaning brushes, kitchen utensils, and cutting boards. Made from a range of materials like corn-starch and sugar to mushrooms and agricultural by-products, bioplastics are the latest attempt to prolong our disposable lifestyle. Stainless

steel options for reusable food and beverage storage have multiplied in recent years. We can replace single-use cups, kitchen storage, lunch boxes, and more with this durable metal. While not biodegradable, glass is inert, inexpensive and infinitely recyclable. And since many food items come packaged in glass, upcycling glass jars into food storage is a no-cost way to give food packaging new life. Natural cloth can replace plastic bags. Sustainable clothing made from organic cotton, wool, hemp, or bamboo won't shed plastic fibres when washed. Felted or recycled wool is a versatile, safe, and compostable material for children's toys, household containers, and more.

Other than these, bioplastics can be used to replace traditional plastics. Bioplastics are a type of plastic that can be made from natural resources such as vegetable oils and starches. Non-edible Castor oil can be used in the process of making the polymer which can be moulded into sheets having properties suitable for making bags, cutlery or containers. The material so made is biodegradable, leak-proof and non-toxic and help in reducing the Single Use Plastic usage in the environment.

Summing it all up, plastic, which once used to be a boon has become a bane due to indiscriminate intensive use in daily lives. Being the root cause and also an indirect player in several calamities, the severity of an inevitable deteriorated-future can be reduced by clever use and opting for alternatives to plastic whenever possible. Spreading awareness through campaigns, workshops, etc. in the grassroot levels among the common man should be a main priority if we were to reach the goal of zero single use plastic by 2030 which being a great feat in itself will motivate others in the world community to come together in this fight against the man-made menace-plastic-for a better and sustainable world.

PLASTICS
AND ITS ALTERNATIVIVES

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Defination & compositions of PLASTIC

Plastic is any synthetic or semisynthetic organic polymer. In other words, plastic is a petroleum product, in which other elements might be present – plastic always includes carbon & hydrogen. While plastics may be made from just about any organic polymer, most industrial plastic is made from petrochemicals. Thermoplastics & thermosetting polymers are two types of plastics.

Plastics are often referred to by the acronyms for their chemical formulas-

- Polyethylene terephthalate-PET/PETE
- High density polyethylene-HDPE
- Polypropylene-PP
- Polystyrene-PS
- Low density polyethylene-LDPE

Eco-friendly alternatives

Many eco friendly alternatives can be used in order to avoid plastic adverse effects on health & environment. Although plastic as we know was introduced less than 100 years ago, it has quickly become a staple in our everyday lives- from light switches to cars to computers, plastics are unavoidable. Unfortunately, this explosion in plastic products has been devastating our environment. Synthetic plastics are not biodegradable, which means that once they're going to be with us in our landfills and oceans, they will be their for 100 if not 1000 of years. There is also a whole laundry list of toxic chemicals that leak into air, water and soil from the manufacturing and disposal of plastics. Recycling can help alleviate some of these problems,but the best way to protect the earth from plastics is to replace them with more eco-friendly materials.

A) Metal, Wood & Glass

One of the best ways to get rid of plastic in your home or business is to choose products made from more traditional materials like metal, wood or glass that are cleaner to manufacture and easier to dispose of Glass, along with metals like aluminium and steel, can be recycled indefinitely, meaning they don't have to end up in landfills, and wood is also easier to reuse and dispose off. These products are usually more expensive, but their durability and green lifecycle make them worth the price.

Another thing to keep in mind- when buying wood products try to make sure they are eco-friendly and come from sustainable harvested forests. You can look for labels from the F.S.C . which certifies the wood products.

B) Bagasse

Compostable, eco-friendly bagasse is great for replacing plastic when u need disposable plates, cups or take-out boxes. Bagasse the pulp left over when juice is extracted from sugarcane or beets, is used for a variety of purposes including as a biofuel . It can also be pressed into a cardboard like material used to make waterproof manufacturing food containers, which is a great use as manufacturing from waste that would otherwise be thrown away. Because it's made from plants, it will biodegrade easily in a home or industrial compost pile.

C) Bioplastics

Sometimes its hard to find non-plastic versions of the products u need, so when u have to rely on plastics try to find eco- friendly ones. PLA/CPLA are made from corn instead of petroleum while taterware is a similar material made from potato starch. Many companies are also now starting to manufacture bottles and packaging using PLA or other plastics made from non-petroleum sources.

D) Chicken Feathers

The united states found out that disposing of chicken feathers is a problem, but with the help of innovation, they can be a material useful to make a water-resistant thermoplastic.

E) PCL Polyesters

Polycaprolactone is a synthetic aliphatic polyester that's not created from renewable resources but can degrade after weeks of composting.

F) Milk Protein

Scientists indicate that milk protein can help produce a biodegradable plastic to make insulation, furniture cushions, packaging and other products. India, taking cognizance of the fact that,3.5 million tons of plastic were produced during 2020-21 and that its recycling capacity is only half as such, decided to discontinue the manufacture, import, stocking, distribution, sale and use of identified single use plastic (SUP) items that have low utility and high littering potential from 1stJuly 2022. It is hoped that this will help create a golden opportunity for India to emerge as a global leader to solve plastic pollution through strict legislation, innovative alternatives and awareness.

PLASTICS
AND ITS ALTERNATIVIVES

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Introduction:

Plastic pollution is a great crisis of modern world.Peoples are using it endlessly , but no one realizes how it is harming our environment. Now time has come to think about alternate use of plastics in order to save the nature and all living organisms from the path of devastation.

A survey of Central Pollution Control Board of India reveals that 3.3 million metric tonnes of plastic waste were generated by Indians in 2018-19. Another alarming statistics is that of all plastic waste produced in the world, 79% enters the environment and only 9% of them are recycled. Accumulation of plastic waste is a great threat to the environment and when this waste finds its way into the sea,it causes lot of damage to the marine ecosystem. Also some percentage of plastic waste used in land filing causes permanent damage to the soil fertility and the rest were burnt to pollute the atmosphere by releasing poisonous chemicals.

A research study from Indian Institute of Science, Bengaluru non-edible castor oil was used in the process of making the polymer which involves allowing them to react with the cellulose and di-isocyanate compound.These polymers can be moulded into sheets having properties suitable for making bags, containers which are biodegradable and non-toxic to the environment. So such polymers will be helpful in packaging sector, tackling agricultural stubble problem, health care application also.

Besides this, bioplastics can be used to replace traditional long lasting non-biodegradable plastic like natural fibre, paper silicone , bamboo pottery etc. Also stainless steel, glass products , ceramics product can be used as alternative of single use plastics.

Now-a-days many companies are using natural alternative packaging methods. Mushroom packaging is most commonly used to replace styroform packaging. Sea-weed based packaging is also biodegradable and sustainable in this regard. Pressed hay is being used as egg cartoon in Poland.Banana-leaves and Bamboo packaging is used in Thailand as substitute of single use plastic.

In order to avoid and alarming environmental situation we should change our life style by doing the following practices and in my opinion we should change our habit accordingly.

- Use plastic free beverage container.
- Ditch the plastic bags
- Switch on to non–liquid soaps.
- Choose glass, metal or unlined paper packaging whenever possible.
- Use of reusable bags.
- Use of reusable cutlery.
- Use of dishwash power.
- Use of Natural sponge.
- Use of Menstrual cup or reusable cloth sanitary napkins.
- Use of bamboo toothbrushes .
- Use of shampoo bar.

Conclusion:

India has a long history of using natural materials for different purpose and hence I hope in near future we should come up with more radical solutions to solve the present crisis naturally.Nature has solution to every problem. PM NarendraModi, in his Independence Day speech in 2019appealed and urged people to rid India of single use plastics. To tackle plastic waste & worsening pollution, India has banned 21 single use plastic (SUP) items such as plates, cups, cutlery straws, packaging films and cigarette packets etc. w.ef.1st july 2022. Without blaming to any one or any organisations who produces those things or the Government at large, we should take our own decision not to use plastic, in order to save our family and environment. If everyone will think and act positively towards our environment, Mother Earth will not only recover soon but also the future of coming generation will be eco- friendly. Think Green Go Green.

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