WEDNESDAY 20th AUGUST, 2025 SUSTAINABLE DEVELOPMENT GOALS YOUTH SUMMER CAMP

# Trends and Options of Plastic Alternatives

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# Introduction

### PLASTIC ALTERNATIVES OVERVIEW

Introduction to Global Trends and Scientific Criteria in Selecting Sustainable Plastic Alternatives

### CURRENT PLASTIC USE AND CHALLENGES

Discuss the widespread production of over 430 million tons of plastic annually (UNEP 2024), and its impact on marine ecosystem, human health (microplastics), and global waste crises

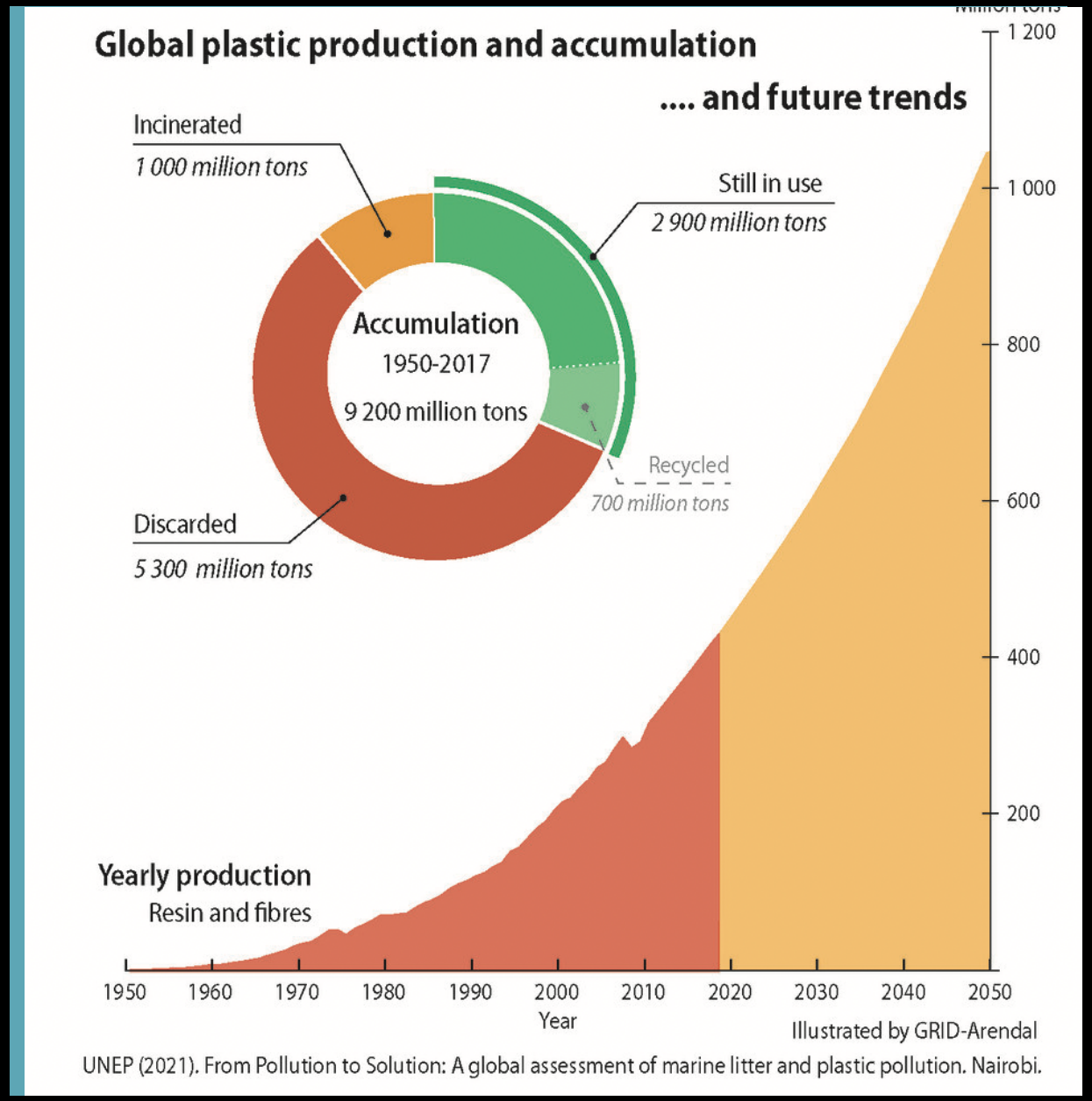
### EXPLORING SUSTAINABLE OPTIONS

Highlight the global shift driven by policy (e.g., EU PPWR 2024, INC-5) and innovation (e.g., seaweed-based, mycelium materials) toward verifiably eco-friendly and biodegradable alternatives)

### CRITERIA FOR EVALUATING ALTERNATIVES

Outline the selection criteria based on Life Cycle Assessment (LCA), including carbon footprint, recyclability, industrial compostability, performance, and economic feasibility

THIS INTRODUCTION SETS THE STAGE FOR A COMPREHENSIVE EXAMINATION OF THE TRENDS AND SELECTION OF PLASTIC ALTERNATIVES SHOULD AIM TO ADDRESS BOTH SHORT-TERM PACKAGING NEEDS AND LONG_TERM ENVIRONMENTAL GOALS IN LINE WITH THE UPCOMING GLOBAL PLASTICS TREATY




UNEP (2021). From Pollution to Solution: A global assessment of marine litter and plastic pollution. Nairobi.

# The Problem with Plastics

Global plastic production has exceeded 430 million tons per year as of 2024, with cumulative plastic waste projected to surpass 9 million tons by 2050 (UNEP, 2024). Despite growing awareness, less than 9% of all plastic ever produced has been effectively recycled. Traditional fossil-fuel-based plastics persist in the environemtn for hundreds of years. Plastic waste increasingly contaminates not only oceans and soil, but also human biological systems. Microplastics have been ditected in human blood, lungs, placenta, and breast milk (Wright et al., 2023). Future trends suggest that without systemic change, plastic production could double by 2050 (OECD, 2023). This underscores the urgency of a legally binding international plastics treaty currently under negotiation (INC-5, UNEP 2024)

# Types of Plastic Alternatives

### BIODEGRADABLE PLASTICS

Biodegradable plastics are designed to break down under specific industrial conditions. Some require high temperature and controlled composting environments to degrade effectively.  (UNEP, 2024)

### BIO-BASED PLASTICS

Bio-based plastics are derived form renewable biomass such as corn or sugarcane, but not all are biodegradable or recyclable. (European Bioplastics, 2024)

### RECYCLED PLASTICS

Recycled plastics are produced form post-consumer or industrial plastic waste, but only a small fraction of plastic is effectively recycled due to contamination and design limits. (OECD, 2023).

https://youtu.be/9vFJHQxPbDY?feature=shared

# Biodegradable Plastics

## BENEFITS

Can significantly reduce long-term environmental impcat if collected and processed through proper composting infrastructure

Derived from renewable resources (e.g., starch, cellulose, seaweed)

Some types (e.g., PHA) fully biodegradable in marine  or soil environments

Align with circular economy principles and extended producer responsibility (EPR) policies

## CHALLENGES

High production cost compared to conventional plastics

Industrial composting infrastructure often lacking or imcompatible

MIsleading claims aout biodegradability create consumer confusion (Greenwashing risk)

Lack of international standards (e.g., ASTM D6400 vs. ISO 17088)

Difficulties in mechanical recycling of certain bio-based plastics

## Key types

polyhydroxyalkanoates (PHA),

cellulose-based plastics,

starch-based plastics,

Seaweed-based materials (e.g., Notpia)

Mycelium foams


Reference

UNEP (2024). Turning the Tide on Plastic Pollution

European Bioplastics (2024). Environmental Communication Guidelines

OECD (2023)/ Global Plastics Outlook - Policy Scenarios to 2060

ISO/ASTM biodegradability standards

# Bio-based plastics

Comparing the key environmental and cost factors of bioplastics and traditional plastics

# Recyclable Plastics

## THE PROBLEM WITH PLASTIC WASTE

Global plastic waste has exceeded 9 millio tons, with less than 10% effectively recycled. Beyond environmental harm, microplastics are now found in human blood, lungs, placenta, and breast milk (UNEP, 2024; Wright et al., 2023), raising public healthe concerns

## IMPROVING PLASTIC RECYCLING

While expanding recycling infrastructure is critical, real impact depends on improving plastic design, standardizing materials, and integrating Extended Producer Responsibility (EPR). OECD (2023) reports that design incompatibility prevents most plastics from being truly recyclable.

## INNOVATION IN RECYCLABLE PLASTICS

Recent policy shifts (e.g., EU Packaging and Packaging Waste Regulation - PPWR, 2024) enforce “design-for-recycling” standards. Industry is now exploring mono-material packaging, advanced mechanical recycling, and certified compostable bioplastics.

## THE ROLE OF CONSUMERS

Consumers remain essential actors - but need regulatory support like clear labeling (e.g., “industrial compostable only” and access to collection systems. Initiatives like deposit-return schemes and reuse platforms (e.g., Loop) demonstrate consumer influence when systems align

# Emerging Trends in Plastic Alternatives

**2019**

Rise of compostable packaging from seaweed, mycelium, and algae.

**2020-2022**

Rapid growth in bioplastics from agricultural wast (e.g., banana stems, sugarcane bagasse). Startups like Genecis and Traceless gaining EU and UNDP support.

**2023**

Smart packaging with digital watermarking (HolyCrail 2.0) piloted in Europe for improved waste sorting and traceability.

**2024**

EU PPWAR (Packaging with digital waste regulation) introduces mandatory reuse and recyclability design standards.

**2025**

Integration of AI-enabled robotics in material recover facilities (MRFs)

Expanding of ocean-bound plastic upcycling platforms

Asia-Pacific pushes Extended Producer Responsibility (EPR) into SMEs

**2026 ~**

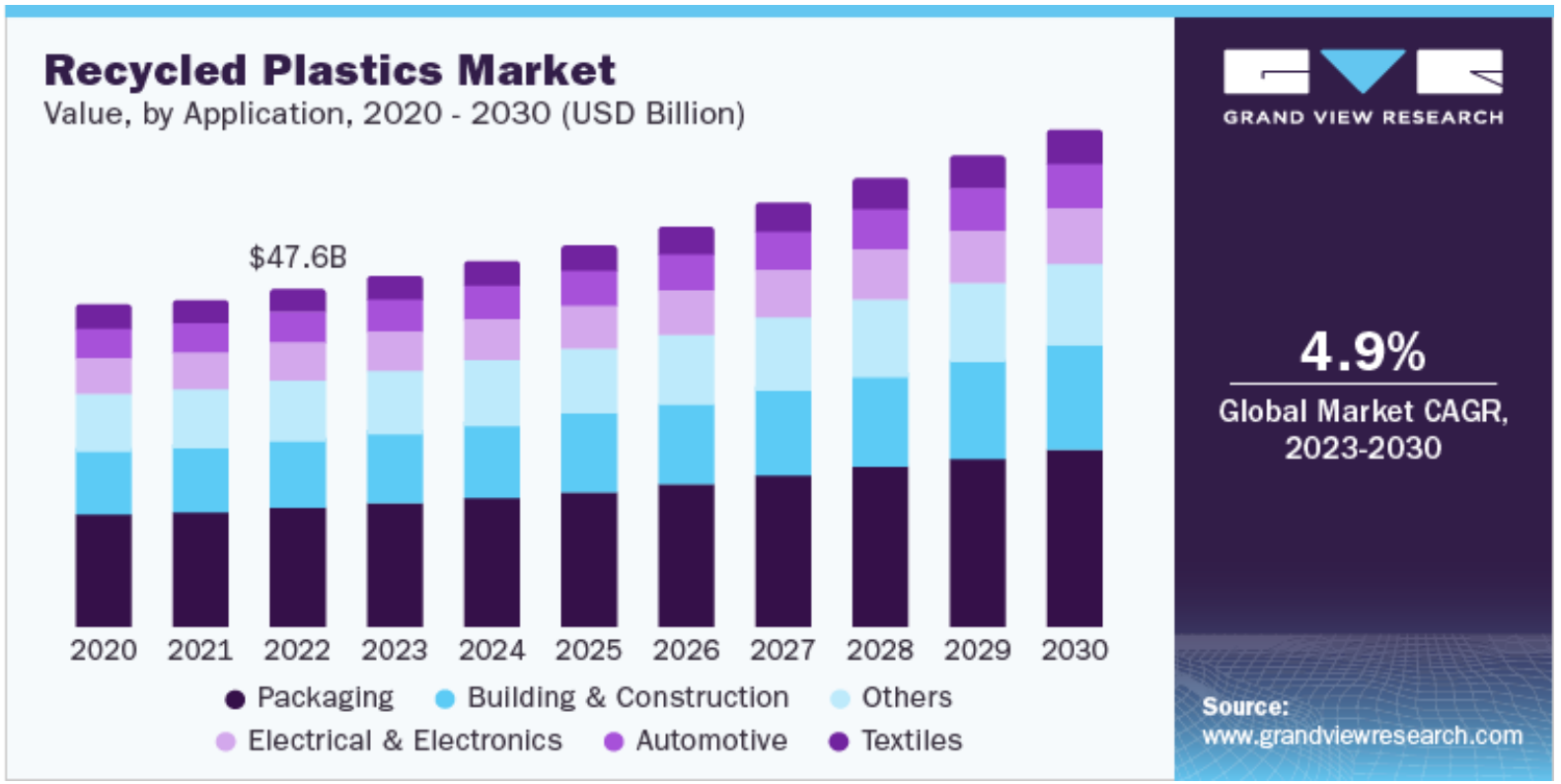
Summer 2025

# Market Trends

"Driven by global regulations and ESG mandates, the plastic alternatives market is projected to surpass $68.5 billion by 2032, growing at a CAGR of 11.2% from 2023 (Allied Market Research 2024)”

"While Europe and North America lead in R&D and policy, Asia-Pacific is now the fastest-growing market, with Korea, Japan, and China adopting mandatory extended producer responsibility (EPR)"

"Packaging remains the dominant application (~65%), but growth is accelerating in sectors like electronics, medical devices, and flexible textiles using biodegradable polymers."



# Factors to Consider

## Economic Feasibility

- Raw material cost, CAPEX/OPEX
- Carbon pricing and compliance cost
- Potential for scale-up and public subsidies

## Environmental Peformance

- Lifecycle carbon footprinct (LCA-certified)
- Biodegradability (ASTM D6400, ISO 17088)
- Marine/soil degradation potential

## Mechanical & Functional Properties

- Tensile strength, flexibility, thermal stability
- Barrier performance (moisture, oxygen)
- Food contact safety (FDA/EFSA)

## REGULATORY COMPLIANCE

- EU PPWR, US EPA guidlines, Korean EPR targets
- Green Claims Directive (EU 2024): verified LCA
- Product traceability requirements (Digital Product Passport)

## Suppluy Chain and Infrastucture Fit

- Feedstock availabilityand regional dependency
- Compatiability with composting/recycling infrastructure
- Scalability in local markets

## Market Acceptance

- Branding, design flexibility
- Consumer trust (eco-labels, certifications)
- Behavioral nudges (e.g., deposits, reuse systems)

Quick Guide

# How to Evaluate Plastic Alternatives (2025)

## LIFECYCLE ASSESSMENT FLOWCHART

Life cycle assessment is crucial in evaluating the overall impact of each alternative

## ENVIRONMETAL CRITARIA

Environmental criteria focus on biodegradability, carbon footprint, and resource renewability

## ECONOMIC CRITERIA

Long-term economic benefits often outweigh initial higher costs associated with sustainable alternatives

## TECHNICAL CRITERIA

Alternatives must meet the functional demands of various applications

# Policy Support and Recommendations

- **R&D FUNDING**

  This funding is crucial for developing innovative technologies and solutions, particularly in the field of plastic alternatives. By investing in R&D, governments can foster technological advancements and promote sustainable practices.

- **TAX INCENTIVES**

- **REGULATORY FRAMEWORKS**

  Analyze the physical and chemical properties of the plastic alternative, such as tensile strength, flexibility, heat resistance, and compatibility with existing manufacturing processes. (Nature, 2023)

- **INTERMATIONAL COLLABORATION**

  Assess the availability and reliability of the plastic alternative's supply chain, including the sourcing of raw materials, production capacity, and distribution channels. (Innova Market Insights, 2023)

- **CONSUMER EDUCATION**

  Consider the target market's perception and acceptance of the plastic alternative, including factors like aesthetics, branding, and end-user experience. (UNEP, 2021)

# Case Studies


## ECOVATIVE DESIGN (USA) - MYCELIUM-BASED PACKAGING

- Mycelium (mushroom roots) grown in molds to create packaging.
- Used by IKEA, Bolt Threads, and BMW for sustainable interior panels.
- Industrially compostable and emits 90% less CO2 vs EPS foam (UNEP, 2024)

## LOLIWARE (USA) - SEAWEED-BASED STRAWS

- Edible, marine-biodegradable straws made from red algae
- Expanded B2B contracts with Delta Airlines, Hilton Group (2024 -2025)
- Certified home compostable (BPI, TUV OK Compost HOME)

## BIOTECH INNOVATIONS (INDIA) - BANANA LEAF TABLEWARE

- Heat-pressed dried banana leaves to from plates/bowls.
- Naturally antimicrobial, free from plasticizers or coating
- Endorsed hy Indian Ministry of Food Processing; adopted in 1,000+ school lunch programs


## VERTERRA (USA) - WHEAT STRAW CUTLERY

- Uses agricultural residue; 100% backyard compostable
- Contracts with city governments (e.g., San Francisco) under palstic-ban ordinances
- Meets ASTM D6400 & FDA food-contact standards


# Thank you

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