

Uttar Pradesh Bioplastic Industry Policy, 2024

Introduction

1. Bioplastics are a category of plastics derived from renewable biological resources such as plants, algae and micro-organisms, as opposed to Traditional plastics that are manufactured from fossil fuels. They are designed to mitigate the environmental impacts associated with traditional plastics, particularly with respect to carbon footprint and biodegradability. Bioplastics are increasingly being recognized as a potential solution to address environmental and economic challenges and represent one of the fastest-growing categories within the bio-based products sector.
2. Multiple countries have undertaken initiatives and significantly enhanced awareness regarding the adoption and use of bioplastics. Under the European Union's Plastics Strategy, all plastic packaging is envisaged to be manufactured from renewable feedstock by 2030 and recycled through existing post-consumer recycling systems. The global bioplastics market has witnessed substantial growth over the past decade, driven by increasing environmental awareness, supportive legislative measures and growing consumer demand for sustainable products. The global bioplastics market size is estimated at approximately US\$ 96.6 billion in 2023 and is projected to reach US\$ 1,353.3 billion by 2033. The market is expected to expand at a Compound Annual Growth Rate (CAGR) of 30.2% during the forecast period from 2023 to 2033.
3. Bioplastics can play a significant role in advancing a circular economy by reducing waste generation and facilitating recycling and composting. By reducing dependence on fossil fuels and lowering greenhouse gas emissions, bioplastics contribute to climate change mitigation efforts. Supported by technological advancements, enabling policy frameworks and increasing consumer preference for sustainable products, the bioplastics industry is well-positioned for sustained growth and innovation.

The potential environmental Advantages of bioplastics make them an important component of future strategies to reduce plastic pollution and promote sustainability. The adaptation and promotion of bioplastics promotes a circular and sustainable economy, which is in line with the goal of fighting climate change.

4. Types of Plastics

A. Fossil-Based Plastics

(i) Traditional Plastics :

- Derived from fossil fuel-based feedstocks such as petrochemicals and petroleum.
- Includes Traditional plastics such as Polypropylene (PP), Polyethylene Terephthalate (PET), and Polyamide (PA).
- Fossil-based plastics are neither biodegradable nor easily recyclable.

(ii) Biodegradable Plastics

- Derived from fossil fuel-based feedstocks such as petrochemicals and petroleum.
- Common types include polybutylene adipate terephthalate (PBAT) and polycaprolactone (PCL), which are biodegradable.
- These are a small subgroup of fossil-based plastics that are biodegradable over an extended period, but their usage is limited compared to traditional plastics.

B. Biomass-Based Plastics (Bioplastics)

(i) Biodegradable Bioplastics

- **Polylactic Acid (PLA):** Derived from sugars and starches obtained from crops such as sugarcane and maize. PLA is used in packaging, disposable tableware and medical devices. It biodegrades into lactic acid over time and is one of the most widely used bioplastics. PLA is a type of biodegradable plastic designed to decompose into non-toxic, naturally occurring constituents under composting conditions.
- **Polyhydroxyalkanoates (PHA):** Produced through the bacterial fermentation of sugars and lipids. PHAs are used in packaging, agricultural films and medical implants.
- **Starch Blends:** Manufactured by blending starch with other biodegradable polymers. These materials are used in packaging and agricultural applications.

(ii) Non-Biodegradable Bioplastics: These bioplastics are derived from biomass but are not biodegradable.

- **Bio-Polyethylene (Bio-PE):** Manufactured from ethanol derived from sugarcane or maize. It possesses properties similar to conventional polyethylene and is used in packaging applications and bottle manufacturing.
- **Bio-Polyethylene Terephthalate (Bio-PET):** Similar to Bio-PE, Bio-PET is used in beverage bottles and packaging applications.

5. Difference Between Petroleum-based/Traditional Plastics and Bioplastics:-

Parameters	Petroleum-based/Traditional Plastics	Bioplastic
Source	These plastics are derived from fossil fuels (non-renewable fossil fuels) such as petroleum, coal and gas.	Derived from renewable biological sources such as plants, algae and microorganisms. Common raw materials include corn starch, sugarcane, potatoes and cellulose.
Production	Fossil-based plastics are produced through the refining and polymerization of petrochemical feedstocks. For example, polyethylene is manufactured by polymerizing ethylene, which is derived from crude oil or natural gas.	Bioplastics are produced through the fermentation and polymerization of organic materials. For example, polylactic acid (PLA) is manufactured by fermenting plant sugars into lactic acid, which is then polymerized into PLA.
Environmental Impact	Carbon Footprint: The extraction, refining and processing of fossil fuels result in a high carbon footprint. Biodegradability: Plastics are generally not biodegradable and persist in the environment for hundreds of years, contributing	Carbon Footprint: Generally associated with a lower carbon footprint, as the carbon dioxide absorbed by plants during their growth cycle can partially offset the emissions generated during the production process.

	significantly to plastic pollution. Renewability: They are composed of non-renewable resources, which contribute to environmental damage and resource depletion.	Biodegradability: Many bioplastics are designed to be biodegradable or compostable under specified conditions, thereby helping to reduce plastic pollution. However, not all bioplastics possess biodegradable characteristics. Renewability: Manufactured from renewable resources, thereby contributing to sustainability and reducing dependence on finite fossil fuel reserves.
Properties and Performance	Mechanical Properties: Generally, they possess well-developed mechanical properties such as high durability, flexibility and thermal resistance which make them suitable for a wide range of applications. Consistency: Fossil-based plastics possess consistent and predictable performance characteristics, making them a preferred choice for numerous industrial applications.	Mechanical Properties: The mechanical properties of bioplastics may differ from those of conventional plastics. Certain bioplastics, such as PLA, exhibit lower thermal resistance and mechanical strength, which may limit their suitability for specific applications. Diversity: The development of bioplastics has led to the emergence of a wide range of materials with varying properties, including both flexible and rigid structures, thereby enabling their use across diverse applications and end-use requirements.

Economic Considerations	Cost: Generally less expensive due to well-established production infrastructure, economies of scale and lower feedstock costs. Market Dominance: Widely utilized across various industries, including packaging, automotive, construction and electronics, owing to their cost-effectiveness and versatility.	Cost: Bioplastics are generally more expensive than fossil-based plastics due to the higher costs associated with raw materials and production processes. However, costs are expected to decline with technological advancements, process improvements and the realization of economies of scale. Market Penetration: Increasing use in specific applications such as packaging, agriculture, and medical devices is driven by consumer demand and environmental regulations.
Applications	Packaging: Used in a wide range of packaging applications, including bottles, containers, films and bags. Automotive: Used in interior and exterior components, as well as fuel systems. Consumer Goods: Used in electronics casings, toys, household items and textiles.	Packaging: Used in food packaging, disposable tableware and bags. Agriculture: Used in mulch films, plant pots and controlled-release fertilizer. Medical: Used in biodegradable sutures, drug delivery systems and medical implants.

6. Compostable Plastics

Compostable plastics are a category of biodegradable plastics that are designed to break down into non-toxic, naturally occurring constituents under composting conditions. They decompose through the action of microorganisms, such as bacteria and fungi, typically present in industrial composting facilities. Compostable plastics offer a

promising solution to the environmental challenges associated with conventional plastics. By degrading into non-toxic natural elements under composting conditions, they help reduce plastic pollution and contribute to improved soil health. However, to realize their full potential, further improvements are required in composting infrastructure, consumer awareness and cost-effectiveness.

i. Decomposition Conditions:

- **Temperature:** Compostable plastics require elevated temperatures, typically ranging between 50°C and 70°C, which are generally available in industrial composting facilities.
- **Moisture:** High moisture levels are required to facilitate microbial activity and support the decomposition process.
- **Microbial Activity:** High moisture levels are required to facilitate microbial activity.
- **Time Limit:** Compostable plastics are designed to decompose within a specified period under appropriate composting conditions.

ii. End Products:

- **Non-Toxic Residues:** Compostable plastics initially break down into smaller fragments, which subsequently decompose into water, carbon dioxide and biomass (humus), leaving no toxic residues.
- **Soil Enrichment:** The compost obtained from the decomposition process can be utilized to enrich soil, enhance plant growth and improve overall soil health.

Environmental Impact:

Compostable plastics offer several environmental advantages:

- **Reduction in Plastic Pollution:** By decomposing completely under appropriate composting conditions, compostable plastics help reduce long-term plastic pollution and micro-plastic contamination.
- **Sustainable Waste Management:** They support the principles of a circular economy by converting waste into valuable compost, which can be used to enrich soil.

- **Lower Carbon Footprint:** The production of compostable plastics often involves the use of renewable resources, thereby reducing dependence on fossil fuels and contributing to lower greenhouse gas emissions.

Challenges and Considerations

Despite their advantages, compostable plastics face some challenges:

- **Infrastructure:** Effective composting requires proper industrial facilities, which are not always available or accessible.
- **Contamination:** Improper management or unsuitable disposal may lead to the contamination of recycled streams or incomplete decomposition in non-ideal environments.
- **Cost:** Compostable plastics are generally more expensive than traditional plastics, which may act as a barrier to their widespread adoption.

While both biodegradable and compostable plastics offer environmental advantages over fossil-based traditional plastics and additive-triggered biodegradable plastics, they differ significantly in terms of definitions, applicable standards, environmental conditions required for degradation, end products, applications and overall environmental impact. Understanding these distinctions is essential for making informed decisions regarding their use and ensuring that they are disposed of in a manner that maximizes their ecological Advantages.

7. Bioplastics Value Chain

The production of bioplastics involves an extensive value chain, ranging from raw material sourcing to end-use applications and end-of-life management. A detailed description of each stage of the bioplastics production value chain is provided below:-

a. Source of Raw Materials

Biomass feedstocks are used as the primary raw materials for the production of bioplastics. Bioplastics are derived from renewable biological resources such as maize, sugarcane, potatoes, cassava and cellulose obtained from wood or agricultural residues. Biomass is processed to extract fermentable sugars or other feedstocks required for bioplastic production. For instance, sugars or starch are extracted from sugarcane, maize or rice for the production of

Polylactic Acid (PLA), while sugarcane is used as a feedstock for the production of Bio-Polyethylene (Bio-PE).

b. Fermentation and Polymerisation

Biomass feedstocks are converted into monomers through microbial fermentation processes. For example, sugars are fermented to produce lactic acid for PLA production or ethanol for Bio-PE production. Enzymes may also be utilized to convert biomass into fermentable sugars or other intermediate compounds. The monomers obtained through fermentation are subsequently polymerised through chemical processes to produce bioplastics. For example, lactic acid monomers are polymerised to form PLA. Biocatalysts may also be employed to facilitate the polymerisation process, thereby enhancing efficiency and reducing environmental impacts.

c. Compounding and Processing

Polymers are blended with additives to enhance properties such as flexibility, sustainability and biodegradability. Intensive blends of colours and additives are prepared to ensure consistent quality in the final product. Bioplastic pellets are melted and extruded into various forms, such as films, sheets, or fibres. The molten bioplastic is injected into molds to create products with complex shapes, such as containers, utensils, and automotive parts. Bioplastic sheets are heated and molded into products such as trays, lids and packaging.

d. Product Manufacturing

- **Packaging:** Bioplastics are used in the manufacture of packaging materials such as bottles, bags and films.
- **Agriculture:** Utilized in products such as mulch films, plant pots and biodegradable nets.
- **Consumer Goods:** Bioplastic components in electronics, toys and household items.
- **Automotive:** Interior components and trim parts made from bioplastics.
- **Medical Devices:** Used in biodegradable sutures, drug delivery systems and medical implants.

e. Distribution and Marketing

Manufacturers distribute bioplastic products directly to industries such as packaging, automotive and consumer goods. Bioplastic products are sold through retail chains, wholesalers and online platforms.

f. End-of-Life Management and Recycling

- **Mechanical Recycling:** This type of recycling often involves down cycling; the material breaks down and is not used continuously.
- **Chemical Recycling:** Advanced processes break down bioplastics back into virgin monomers or other useful chemicals, which are then used for repolymerization or other applications.
- **Organic Recycling:** In a controlled environment, natural processes convert compostable plastics into CO₂, water and nutrient rich fertilizer under aerobic conditions and into biogas, water and nutrient rich fertilizer under anaerobic conditions.

g. Incineration and Energy recovery

- Bioplastics can be incinerated in waste-to-energy plants to recover energy, although this is not a popular practice.

8. Regulatory Compliance and Standards

- **Biodegradability:** Certifications such as ASTM D6400, EN 13432 and ISO 17088 ensure that bioplastics meet prescribed biodegradability and compostability standards.
- **Safety and Quality:** Compliance with food regulations (e.g., FDA, EFSA, FSSAI) and other industry-specific standards.

9. Top Five Largest Global Bioplastics Projects

(a) NatureWorks LLC Plant (Blair, Nebraska, USA):

- **Product:** Polylactic Acid (PLA)
- **Capacity:** 150,000 metric tonnes per annum
- **Description:** NatureWorks operates one of the world's largest PLA production facilities, supplying bioplastics for applications in packaging, textiles and consumer goods.

(b) Braskem Green Ethanol Plant (Truinfo, Brazil):

- **Product:** Bio-Polyethylene (Bio-PE)

- **Capacity:** 200,000 metric tonnes per annum
- **Description:** Braskem's facility produces polyethylene from sugarcane-derived ethanol, which is utilized in packaging, automotive and consumer product applications.

(c) Total Corbion PLA Plant (Rayong, Thailand):

- **Product:** Polylactic Acid (PLA)
- **Capacity:** 75,000 metric tonnes per annum
- **Description:** This joint-venture facility manufactures high-performance PLA bioplastics for a variety of applications, including packaging and consumer goods.

(d) Novamont Plant (Terni, Italy):

- **Product:** Starch Blends and Biodegradable Plastics
- **Capacity:** 150,000 metric tonnes per annum
- **Description:** Novamont's facility produces Mater-Bi bioplastics, which are vastly used in packaging, agricultural and disposable items.

(e) BASF SE Biodegradable Polymer Plant (Ludwigshafen, Germany):

- **Product:** Ecoflex and Ecovio (Biodegradable Plastics)
- **Capacity:** 74,000 metric tonnes per annum
- **Description:** BASF's facility manufactures a range of biodegradable plastics for use in packaging, agriculture and consumer goods applications.

10. Bioplastics Parks

Bioplastic Parks are specialized industrial zones dedicated to the production, processing and trade of bioplastics. These parks aim to create a comprehensive ecosystem that covers the entire value chain from raw material production to final bioplastic products. Some notable Bioplastic Parks and their details are as follows:

a) Bio-on Industrial Park (Italy)

- **Location:** Castel San Pietro Terme, Bologna, Italy
- **Description:**
 - **Scope:** Bio-on Industrial Park is one of the most comprehensive bioplastics parks in Europe, focusing on the entire bioplastics value chain.

- **Facilities:** These include a research and development centre, facilities for the production of biopolymers and processing units for converting raw materials into bioplastic products.
- **Products:** Specialized in the production of polyhydroxyalkanoates (PHA) derived from agricultural waste materials.
- **Sustainability:** It emphasizes the use of renewable resources and environmentally friendly production processes, and focuses on reducing carbon footprints and waste.

b) BBP (Biorizon Bioplastics Park), Netherlands

- **Location:** Bergen op Zoom, Netherlands
- **Description:**
 - **Scope:** BBP aims to integrate the entire bioplastics value chain, ranging from biomass feedstocks to finished bioplastic products.
 - **Facilities:** The park includes pilot plants, research laboratories and demonstration facilities for the development and scale-up of bioplastics production technologies.
 - **Collaboration:** Collaborates with multiple research institutions, universities and industrial partners to promote innovation and innovation in bioplastics production.
 - **Products:** Focuses on the production of a variety of bioplastics, including Bio-Based Polyethylene (Bio-PE) and Polylactic Acid (PLA).

c) Green Chemistry and Commerce Council (GC3) (USA)

- **Location:** Various locations across the USA
- **Description:**
 - **Scope:** GC3 is a network of companies, government agencies and research institutions dedicated to advancing green chemistry and sustainable materials, including bioplastics.
 - **Facilities:** Members of the network have access to pilot plants, research facilities and commercial-scale production units located across the United States.

- **Collaboration:** Facilitates partnerships and collaboration among stakeholders to promote the development and commercialization of bioplastics.
- **Products:** Focuses on bioplastics for various applications, such as packaging, automotive and consumer textiles.

d) Kaneka Takasago Biopolymer Plant (Japan)

- **Location:** Takasago, Hyogo Prefecture, Japan
- **Description:**
 - **Scope:** The bioplastics facility forms part of Kaneka Corporation's broader initiative to establish an integrated bioplastics value chain.
 - **Facilities:** The plant includes production units for Polyhydroxyalkanoates (PHA), a category of biodegradable plastics, as well as facilities for converting biomass into feedstocks for bioplastics production.
 - **Sustainability:** Focuses on the utilization of sustainable raw materials and the adoption of efficient manufacturing processes to minimize environmental impacts.
 - **Products:** Produces various types of biodegradable and compostable bioplastics for use in packaging, agriculture and consumer textiles.

e) Biopolis (France)

- **Location:** Saint-Barthélemy-d'Anjou, France
- **Description:**
 - **Scope:** Biopol'is is an industrial park dedicated to the production of biopolymers and bioplastics, integrating the entire value chain from biomass to finished products.
 - **Facilities:** It includes research centres, production facilities and pilot plants for scaling up bioplastic technologies.
 - **Collaboration:** It works in collaboration with educational institutions, research organizations and industrial partners to promote the innovation and commercialization of bioplastics.
 - **Products:** Focuses on the production of bioplastics such as PLA and PHA for applications across industries including packaging, textiles and automotive.

11. Global Policies to Promote Bioplastics

Bioplastic parks have taken a significant step in creating sustainable and circular economies. By integrating the entire value chain, these parks enhance the efficiency and scale of bioplastic production. Government policies and incentives at the global level are significant for the development and adoption of bioplastics, as they contribute to environmental sustainability and reduce dependence on fossil-based plastics. As technology advances and infrastructure improves, bioplastic parks are expected to play a pivotal role in the future. The incentives and support provided by various governments to facilitate the establishment of bioplastic parks and promote bioplastic production are outlined below:-

S.No.	Country	Policy /Programme	Policy Measure
1.	Thailand	Incentives Provided by the Thailand Board of Investment (BOI)	Non-Tax Incentives: • Permission for Foreign Experts: Investors are permitted to employ and bring foreign experts and specialists for their approved projects. • Land ownership permission: Foreign investors are permitted to own land. • No Restrictions on Foreign Currency: There are no limits on the movement and transactions of foreign currency. Tax Incentives: • 8-Year Corporate Income Tax Exemption: A Full tax exemption on manufacture of environment friendly chemicals or polymers or their products.

			• This exemption applies to projects associated with the manufacture of eco-friendly chemicals or polymers. • 5-Year Corporate Tax Exemption: Tax exemption and exemption from import duties on the manufacturing of products using eco-friendly polymers. • 3-Year Corporate Tax Exemption: Tax exemption and exemption from import duties on the manufacturing of paper containers coated with bioplastics. Special Note: • Tax Deductions to Promote Bioplastic Packaging: The Thailand Cabinet provided tax deductions of up to 125% to companies purchasing and using bioplastics from January 2019 to December 2021. Through these incentives, Thailand has taken significant steps toward encouraging investment and production in the field of bioplastics.
2	Malaysia	National Biomass Action Plan 2023-2030 issued by Ministry of Plantation & Commodities	• Green Technology Financing Scheme (GTFS) 4.0: A financing scheme designed for producers and users of green technologies and products offered by Energy Service Companies (ESCOs). • Financing Size – RM50-RM1000 million • Financing period: Up to 10–15 years.

			• Incentive Period: First 7 years. Government Incentives: • 60%-80% Government Guarantee and a 1.5% Discount on the Interest Rate. Malaysian Investment Development Authority (MIDA): • Incentive: Use of palm oil biomass for the production of bioplastics (among other products). • Tax Benefit: Income tax exemption of 70%-100% of statutory income for a period ranging from 5 to 10 years. • Investment Tax Allowance: 60%-100% of eligible capital expenditure incurred within a period of 5 years • Green Investment Tax Allowance (GITA): 100% tax allowance of eligible capital expenditure incurred on a green technology project from 2013 to 2026. • The allowance may be offset against statutory income in the assessment year. • Permission to carry forward unused allowances. Green Income Tax Exemption (GITE): Green technology services related to renewable energy, energy efficiency, electric vehicles, green buildings, green data centres, green certification and verification and green townships are eligible for this tax incentive.
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			• An incentive providing a 100% exemption on statutory income is applicable from 2013 to 2026. • Incentives for BioNexus Status Companies: BioNexus Status Incentives for Companies: Biomass companies specifically those operating in various sectors such as plantations, agriculture, livestock farming and aquaculture that adopt bioconversion technologies (such as biofuels, bioenergy, biomaterials and bioremediation) are eligible to apply for investment incentives under the BioNexus Status granted by the Malaysian Bioeconomy Development Corporation (Bioeconomy Corporation). • Incentives: 100% tax exemption for 10 years; waiver of import duties on imported raw materials and machinery for 10 years.
3	Taiwan	Initiatives Undertaken by the Ministry of Economic Affairs (MOEA), Taiwan for Promoting a Circular Economy	Tax Incentives: • Research and Development (R&D) Tax Incentive: Up to 15% of the company's Research and Development (R&D) expenditure may be deducted from the current year's profit-generating enterprise income tax; alternatively, up to 10% of such expenditure may be credited against the profit-generating enterprise income

			tax payable by the company over a period of three years. Investment in Smart Machinery: - For investments less than NT\$1 million and more than NT\$1 billion, "5% of investment expenses from profit-seeking enterprise income tax (current fiscal year)" or "3% of investment expenses from profit-seeking enterprise income tax, if the total expenses are spread over three years" can be selected but the total amount of deduction must not exceed 30% of corporate income tax in that year. Special Foreign Professionals: - Special Foreign professionals who meet the specified criteria are eligible for a 50% deduction on their total income tax exceeding NT\$3 million. Grants: Global R&D Innovation Partner Program: Upon obtaining approval from the MOEA, a foreign company will be eligible to receive a grant of up to 50% of its total R&D expenditure. Program for the Development of Leading Companies: Program funding may be provided for up to 50% of the total expenditure for any project that has been approved by the Ministry of Economic Affairs.
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			• Taiwan Industry Innovation Platform Program: This program provides funding support of 40%-50% of the required funding for theme-based R&D projects undertaken by companies with R&D teams in Taiwan, and up to 40% funding support for company-proposed R&D projects.
4.	United States of America (USA)	USDA Bio Preferred Programme	Regulatory measures: • Federal Procurement Preference: For certain product categories, federal procurement must contain at least 25% bio-based materials. • USDA Certified Bio-based Product Label: To facilitate the identification of bio-based products, they are marked with the 'USDA Certified Bio-based Product' label. This provides consumers with useful information regarding the verified amount of renewable biological material contained within the product and/or its packaging. Currently, more than 4,500 products are marked with such labels.
5	Japan	Bio-Strategy 2020 Roadmap for Bioplastic Introduction 2021	Government Investment: An investment of ¥6.2 billion was allocated under the 2019 Budget to promote the development of the bio-economy and bio-production sectors. Regulatory Measures: • Roadmap for Bioplastics Introduction: The "Roadmap for

			Bioplastics Introduction" was developed in January 2021. This roadmap aims to increase the volume of bio-based plastic products in Japan from 50,000 tons to 2 million tons by 2030. Its key points are: • Active procurement using the Green Procurement System. • Certification that takes sustainability into account throughout the entire life cycle. • R&D and demonstration projects to improve efficiency, reduce manufacturing costs, and diversify raw materials. • Expansion of bio-plastics manufacturing facilities within Japan. • Facilitate fund raising for setting up of research and development and manufacturing facilities. • Survey and Follow-up on the Introduction Status of Bioplastics. • These policy measures are intended to promote the growth of the bioplastics industry while ensuring environmental sustainability and resource efficiency.
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12. Advantages of bioplastics across the globe

(1) Advantages of Bioplastics –

The key advantages of bioplastics are as follows:-

a) Environmental Advantages

- Reduction in plastic pollution by providing biodegradable and compostable alternatives to Traditional plastics.
- Reduced dependence on fossil fuels, thereby supporting the transition towards a more sustainable and low-carbon economy.

b) Waste Management:

- Bioplastics are designed to be biodegradable, which specifically helps reduce the burden of plastic waste in landfills and oceans.
- Bioplastics can be composted along with organic waste, which is useful for agriculture.

c) Economic Impact

- The production and processing of bioplastics are expected to generate employment opportunities across the value chain, ranging from agriculture to manufacturing.
- In light of the global market demand for bioplastics, the production and marketing of bioplastics will strengthen the economic development of the region.

d) Agricultural Sector:

- The requirement for biomass feedstock in the production of bioplastics will stimulate demand for certain agricultural products, thereby providing opportunities for additional income for farmers.
- Bioplastics will be able to be produced in large quantities from agricultural biomass.

e) Research Update:

- According to research (Loughlin et al., 2023), it is estimated that PLA plastics require only 1.8 kg of carbon per kilogram of bioplastics to produce, compared to 3.1 kg of emissions generated by traditional plastics.
- Bio-Pak, a major bioplastics manufacturer in Australia, has recycled 105 million tonnes of plastic and planted/saved approximately 154,000 trees.
- According to research (Suarez et al., 2022), it is estimated that the use of poly-lactic acid (PLA) for textiles can provide up to an 80% reduction in carbon footprint.

- It is estimated that the bioplastics industry could account for around 300,000 high-skilled jobs in the EU bioplastics sector.
- According to the EU Bioplastics Report, the development of renewable feedstocks for bioplastics requires very little arable land. For example, in 2022, 2.2 million tons of bioplastics were produced using approximately 0.015% of global land.

Key Findings:

New and innovative approaches are continuously being developed to integrate bioplastics into existing industrial and economic ecosystems. Government support, through both regulatory measures and incentive-based interventions, is essential for Promoting a circular and sustainable economy. Such support aligns with broader national objectives of combating climate change, enhancing resource efficiency and promoting long-term economic growth and industrial development.

13. Introduction to the Policy in the Indian Context

- The implementation of the ban on Single-Use Plastics (SUP) has paved the way for the bioplastics industry. The growth of industries depends on various factors such as government policy, effectiveness of implementation of regulations, cost competitiveness, public awareness, etc.

14. Regulations

The Government of India had announced a nationwide ban on all single-use plastic (SUP) items, effective from October 2, 2019. Subsequently, due to widespread protests by the plastic industry, this ban could not be implemented. Thereafter, the government issued guidelines for the phased implementation of the SUP ban commencing in October 2021 thereby providing the plastic industry with ample time to prepare. Meanwhile, the bioplastics industry faced significant challenges due to limited government guidelines and issues regarding implementation. Furthermore, the COVID-19 pandemic has also had a substantial impact on the industry.

According to current government guidelines, polyethylene bags thinner than 75 microns have been banned effective September 30, 2021. Furthermore,

effective July 1, 2022, the manufacture, import, stocking, distribution, sale and use of single-use plastics have been prohibited; this includes earbuds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice cream sticks, polystyrene (Thermocol) for decoration, plates, cups, glasses, cutlery (such as forks, spoons, and knives), straws, trays, wrapping or packing films around sweet boxes, invitation cards and cigarette packets, plastic or PVC banners thinner than 100 microns and stirrers. Additionally, effective December 31, 2022, polyethylene bags thinner than 120 microns have also been banned.

Two phases of guidelines, starting from September 30, 2021, are currently in effect across the country. But proper implementation has not taken place in many states. Some states in India have taken it stricter and started using eco-friendly and compostable alternatives.

15. Production and Market

Since September 2021, the industry has witnessed significant growth and positivity, driven by strict restrictions implemented in certain Indian states. Additionally, export markets are also being developed. New players are entering the field of biopolymer compounding, compostable product manufacturing and trading. Till now around 162 companies have registered on the government portal to sell/manufacture/commerce compostable items in India.

In India, many processors are manufacturing a variety of compostable products. However, the primary challenge lies in the availability of raw materials. Key raw materials include PLA, PBAT, Bio-PBS, PHA, etc. These materials are currently being imported into India and global manufacturing capacities for them remain limited. Furthermore, as demand rises, supply often falls short. This is the primary reason why the industry's growth is currently sluggish. As long as an adequate supply of raw materials remains unavailable within India, product manufacturers cannot rule out the risk of having to halt production due to material shortages. Several companies have expressed interest in manufacturing PLA and PBAT within India; such initiatives would catalyze massive growth within the industry and also help improve both the cost-effectiveness and availability of bioplastic raw materials. India possesses abundant organic resources, positioning

it as a potential hub for bioplastics. Some states like Maharashtra, Karnataka and Gujarat have taken some basic initiatives to promote bioplastics manufacturing.

The bioplastics industry in India is in an initial yet promising stage. With increasing environmental regulations, consumer awareness and government support, this sector is poised for significant growth. Several bioplastics plants are emerging across the country, supported by various state incentives and policies aimed at Promoting sustainable development. Although some state governments are providing support in specific areas, there is currently no comprehensive policy in place in any state specifically dedicated to Promoting the growth of the bioplastics industry. As the industry matures, India possesses the potential to emerge as a key player in the global bioplastics market, thereby contributing to a greener and more sustainable future.

Uttar Pradesh, one of India's largest and most populous states, holds significant potential for the development and adoption of bioplastics. The state's diverse agricultural base, robust industrial infrastructure and proactive government policies can be leveraged to boost the bioplastics industry.

16. Potential of Bioplastics in Uttar Pradesh

Uttar Pradesh is one of India's largest sugarcane producers, contributing significantly to the state's agricultural economy. The state's favourable climate and fertile soil conditions support extensive sugarcane cultivation. The availability of sugarcane-based biomass a valuable resource for bioplastics production is substantial, driven by the high volume of sugarcane output. During the 2022-23 crushing season, 118 sugar mills are operating in the state. The total sugarcane area covers 28.53 lakh hectares, and the sugarcane productivity is 839 quintals per hectare. This accounts for approximately 45% of India's total sugarcane production.

The abundant amount of sugarcane-based biomass in Uttar Pradesh presents a significant opportunity for the development of a robust bioplastics industry. By leveraging this resource, the state can promote sustainable industrial development, reduce environmental impact and enhance the economic potential of its agricultural sector. A supportive policy framework and existing infrastructure further strengthen the prospects for establishing a Bioplastics Park.

By leveraging its strengths and implementing strategic initiatives, Uttar Pradesh can contribute to a more sustainable and environmentally friendly future. The following key contributing factors will be crucial in establishing Uttar Pradesh as a bioplastics hub within India and beyond:

(a) Availability of agricultural resources- Rich agricultural base

- **Crops:** Uttar Pradesh is a major producer of sugarcane, wheat and maize, which are the main raw materials for bioplastics such as polylactic acid (PLA) and bio-based polyethylene (Bio-PE).
- **Agricultural residues:** Large quantities of agricultural residues such as sugarcane bagasse can be used as feedstock for bioplastic production, increasing the sustainability and cost-effectiveness of the industry.

(b) Market Demand and Consumer Awareness

- **Consumer Awareness:** Growing awareness regarding environmental issues and the harmful effects of traditional plastics can drive the demand for bioplastics.
- **Sustainable Products:** The preference for sustainable and eco-friendly products is on the rise, particularly in urban areas such as Lucknow, Noida and Varanasi.

Industrial Demand

Low-Value Products	High-Value Products
Packaging: Used in food packaging applications, disposable tableware and bags. Agriculture: Used in mulch films, plant pots and controlled-release fertilizer applications. Consumer Goods: Used in electronic casings, toys, household products and textiles.	Packaging: Used in a wide range of packaging applications, including bottles, containers, films and bags. Automotive: Used in interior and exterior components, fuel systems and under-the-hood applications. Medical: Used in biodegradable sutures, drug delivery systems, and medical implants.

(c) Industrial and Infrastructure Support

- **Existing Industrial Base:**

- **Chemical Industry:** Uttar Pradesh possesses an established chemical industry that can support bioplastics production through existing infrastructure and expertise.
- **Manufacturing Hubs:** New industrial zones where biomass feedstock is available in abundance can be promoted to accommodate bioplastic manufacturing units. This will pave the way for job creation and attract new investments to these regions.

17. Potential Advantages for Uttar Pradesh

a) Employment Generation:

The establishment of a PLA unit can create approximately 2,000 jobs across the value chain (both direct and indirect) specifically in manufacturing (250+), converting (750+), compounding (750+) and recycling units (250+).

b) Revenue growth:

- **Increase in consumption:** Consumption of bioplastics will increase and meet domestic demand.
- **Growth in Investment:** The state holds significant potential for investment within the bioplastics sector.
- **Export Potential:** With the expansion of bioplastic manufacturing units, there is potential for export in the future.

c) Improved Waste Management:

- **New Waste Management Solutions for Uttar Pradesh:**
 - To improve the State's current CPCB environmental performance ranking (33/35) and enhance its overall environmental performance.
 - Reducing the dumping of plastics in landfills.
 - Assisting in achieving the objectives of the Clean Ganga Mission and Namami Gange.
 - Promoting a circular economy.
 - Compostable bioplastics reduce greenhouse gas emissions by breaking down biomass waste through anaerobic processes.

d) Brand Image of the State:

- **Enhancement of the State's Brand Image as an Investment Destination:**
 - Promoting the State's Brand Image as a Preferred Investment Destination:
 - Promotion as a state that encourages sustainability and circular economy.

18. To realize the full potential of **Bioplastics Energy**, a comprehensive bioplastics park under a cluster-based approach is recommended. A cluster-based approach would involve establishing a concentrated geographical area where interconnected companies, specialized suppliers, service providers and related entities converge and collaborate. This approach can be highly beneficial for the bioplastics industry for several reasons:-

- a. Bulk Purchasing and Shared Services:** These will provide economies of scale and lead to cost optimization.
- b. Supply Chain Efficiency:** Locating close to suppliers, manufacturers and distributors will increase the efficiency of the integrated supply chain, thereby improving the cost and efficiency of production processes.
- c. Advantages of Proximity:** Transport costs and time will be reduced, thereby improving overall supply chain efficiency.
- d. Availability of a Skilled Workforce:** Clusters will attract a skilled workforce due to the concentration of job opportunities and specialized training programs.
- e. Advantages of cross-industry learning:** Shared resources will facilitate improved Research and Development (R&D). The cluster will promote closer interaction between various stakeholders, including manufacturers, researchers, suppliers and customers, thereby promoting collaboration and knowledge sharing.

19. Vision & Mission

- **Vision Statement**

“To establish Uttar Pradesh as a global leader in sustainable bioplastics production and innovation by Promoting an environmentally sustainable and economically vibrant ecosystem that contributes to the State's environmental aims, industrial advancement and long-term economic prosperity.”

- **Mission Statement**

"To develop a world-class bioplastics park in Uttar Pradesh by leveraging local infrastructure, advanced structures and mineral resources, with the aim of creating

a sustainable industrial ecosystem that will enhance research, innovation and production of bioplastics, driving economic growth, job creation and environmental sustainability."

20. Objectives

The objectives of the Bioplastics Cluster are as follows:

The aim of the Bioplastics Cluster is to allow all interested parties to establish a complete circular value chain. This involves developing technological, marketing and social solutions that contribute towards a society with a lower environmental impact and ensure acceptable living standards for all. The Bioplastics Cluster will encompass all players across both the supply chain and the recycling chain. The cluster will be supported by equipment suppliers and technology providers, who will be actively engaged in the development of new technologies. The cluster will also include representation from universities and associations, which will provide the necessary expertise and Research and Development (R&D) capabilities for various aspects of technical and economic business development.

Core Participants	Enablers	Distribution	End-of-life	Awareness, R & D
Raw materials producers	Equipment Suppliers	Brand Owners	Waste Collectors	Consumer Organizations/ NGOs
Compounders	Technology Providers	Retailers	Waste Collectors	Communes
Converters			Waste Collectors	Agricultural Organizations
Packaging Companies			Mechanical & Chemical Recycling	Universities
			Organic Recycling/ Biogas	

21. Proposed Objectives of This Policy

(1) World-Class Bioplastics Park:

- Develop state-of-the-art infrastructure to support bioplastics manufacturing, research and development.
- Ensure that the park is equipped with modern facilities that meet international standards for production and environmental management.

(2) Leveraging Local Resources:

- Utilize the state's large agricultural resources, such as sugarcane and maize, for bioplastic production.
- Encourage local farmers to be included in the supply chain and promote sustainable agricultural practices.

(3) Strategic Partnerships:

- Encourage public-private partnerships to attract investment, share expertise and develop necessary infrastructure.
- Promote collaboration with academic institutions, research organizations and industry leaders to facilitate innovation and the exchange of knowledge.
- Partner with global and national companies to reach expertise, investment and market access to the Bioplastics Park.

(4) Advanced Technologies:

- Investing in advance technologies such as advanced polymerization processes, 3D printing and bioreactors.
- Establish research laboratories and innovation centres within the park to facilitate continuous technological advancement.

(5) Sustainable Industrial Ecosystem:

- Promote circular economy practices by encouraging recycling and composting of bioplastic products.
- Implementing environmentally friendly waste management systems to handle by-products and waste generated from bioplastic production.

(6) Research, Innovation and Production:

- To support research and development activities focused on the development of new bioplastic materials and applications.

- Encourage startups and SMEs to participate in the bioplastics value chain, including through incubation programs and financial incentives.

(7) Economic Growth and Employment Creation:

- Creating a significant number of employments in manufacturing, research, logistics and related services.
- Boost economic activity in the region, attract investment and promote local businesses involved in the bioplastics supply chain.

(8) Environmental sustainability:

- To promote the use of bioplastics in order to reduce plastic pollution and minimize the environmental impact of plastic products.
- To raise awareness and educate businesses and consumers regarding the advantages of bioplastics and sustainable practices.

22. Policy Details

The Government of Uttar Pradesh is committed to Promoting a sustainable and innovative bioplastics industry that not only addresses environmental challenges but also supports economic growth and agricultural development. By implementing this comprehensive policy, Uttar Pradesh aims to emerge as a leader in bioplastics production and set an example of sustainable industrial development within India and beyond.

The formulation of an appropriate incentive package requires a holistic approach that addresses the financial, regulatory, market, research and development and infrastructure-related requirements of the bioplastics industry. An indicative framework of an ideal incentive package is outlined below:–

A. Financial Incentives

(i) Assistance and Grants

- Research and Development Grants: Financial support/grants for innovation in bioplastic materials and processes.
- Capital Support: Financial assistance for setting up bioplastic production facilities and related infrastructure.

(ii) Tax Incentives

- Credits: Investment in bioplastic technologies, renewable raw materials and green manufacturing practices.
- Tax Exemption: Exemption for a specified period on equipment and machinery used in bioplastic production and on profits derived from bioplastic products.

(iii) Low-interest loan

- Soft Loans: Financial assistance at low interest rates for startups and established companies to invest in bioplastic technologies.

B. Regulatory Support

(i) Favourable Rules

- Plastic Ban: Creating demand for bioplastic alternatives through the phasing out of traditional single-use plastics.
- Bioplastic Standards: Establishing clear standards and certification to ensure the quality and market acceptance of bioplastics, such as standards under the BIS.

(ii) Accelerated Approval

- Simplified Approvals: Accelerated approval processes for bioplastic projects to ensure timely implementation.

C. Market Development

i. Public Procurement Policies

- Government Procurement: Mandating the use of bioplastics in public sector projects and procurement, including packaging, construction materials and office supplies. For example, the Uttar Pradesh Government will mandate 25% bio-based products in all government departments, airports, hotels, railways.

ii. Consumer Awareness Campaign

- Educational Initiatives: Programs to inform consumers and businesses about the environmental Advantages of bioplastics.
- Marketing Support: Financial and logistical support to promote bioplastic products through trade shows, advertising and public relations campaigns.

D. Research and Development Support

i. Innovation Centre

- **Centres of Excellence:** Establishment of research centres focused on bioplastic innovation, often in collaboration with universities and research institutions.

ii. Collaborative Projects

- **Public-Private Partnerships:** Encouraging collaboration among government, academy and industry to advance bioplastic technologies and applications.

E. Infrastructure development

i. Recycling and Composting Facilities

- **Infrastructure Investment:** Financial support for the development and upgrading of facilities for handling bioplastic waste.
- **Integration with Existing Systems:** Ensuring that the bioplastic waste management system can be seamlessly integrated with the existing organic waste management infrastructure. In every municipality/municipal corporation, it must be ensured that facilities for segregation, thermophilic anaerobic digestion and biogas production are available, thereby enabling the production of CBG (Compressed Biogas)/clean energy and nutrient-rich compost.

ii. Supply Chain Support

- **Raw Material Supply Chains:** Development of robust supply chains for renewable raw materials, such as agricultural feedstocks.
- **Logistics Network:** Establishment of an effective logistics network for the distribution of bioplastic products.

F. International Cooperation

i. Trade Agreements

- **Export Promotion:** Policies to facilitate the export of bioplastic products and technologies, including favourable trade agreements.
- **Global Standards Participation:** Engaging in the development of international standards to ensure access to global markets.

ii. Attracting Foreign Investment

- **FDI Promotion:** Providing tax breaks, grants and other incentives to attract Foreign Direct Investment in the bioplastics sector.

G. Additional Incentive

(i) Workforce Development

- **Training Programs:** Establishment of educational and vocational training programs to develop a skilled workforce for the bioplastics industry.
- **Talent Attraction:** Incentives to attract and retain top talent in bioplastics research and manufacturing.

(ii) Sustainability certification

- **Eco-labelling Programs:** Development of Certification Schemes.

By implementing such incentive packages, governments and stakeholders can effectively promote the development of bioplastic parks, which will be instrumental in driving sustainable economic growth and delivering environmental advantages. The amount of capital support required for a bioplastic park depends on several factors, including the scale of the project, local costs, the type of bioplastics to be produced and regional economic conditions.

Proposed financial incentive package for bioplastics sector participants:

A Bioplastic Park in Uttar Pradesh will be established by a specialized anchor company that produces PLA (Polylactic Acid) pellets using sugarcane biomass. The park will incorporate various Small and Medium Enterprises (SMEs) across the bioplastic value chain to create a comprehensive ecosystem for bioplastic manufacturing and processing.

(*Anchor company that will invest INR 1,000 crore or more for the establishment of a bioplastics plant.)

Proposed Financial Incentives for the Anchor Company for a PLA Project (Investment of INR 1,000 Crore or More):

S.No.	Incentives
1.	Capital subsidy @ 50% of eligible capital investment over a period of 7 years for the anchor unit.

2.	Interest subsidy at a rate of 5% for seven years.
3.	Net SGST reimbursement @ 100% for 10 years.
4.	Exemption from electricity duty for a period of 10 years. The rebate given in electricity charges to the units established under this policy will be reimbursed to Uttar Pradesh Power Corporation Ltd. by the Industrial Development Department.
5.	If the land is purchased after the policy cut-off date, then as per the provisions of Industrial Investment and Employment Promotion Policy 2022, 100% exemption in stamp duty will be provided in Bundelkhand and Poorvanchal region, 75% in Madhyanchal and Paschimanchal (except Gautam Buddha Nagar and Ghaziabad district) and 50 percent in Gautam Buddha Nagar and Ghaziabad district. The date of notification issued for promulgation of this policy will be the cut-off date.
6.	All these Advantages will not exceed 200% of the eligible capital investment over 10 years.
7.	Other units (non-anchor units) will get incentives as per the Uttar Pradesh Industrial Investment and Employment Promotion Policy -2022.

23. Regarding implementation of the above policy, the concerned unit will obtain the required environmental clearance as required under the relevant environmental rules/acts and EIA Notification, 2006 (as amended) and will ensure proper compliance of environmental rules and orders issued from time to time by Hon'ble Courts/Tribunals.

Disclaimer- This document is a translation of the approved Hindi version into English. While every effort has been made to ensure accuracy and clarity, the translated text is provided for reference purposes only. In case of any discrepancies, ambiguities, or differences in interpretation, the original Hindi version shall prevail.
