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HIGHLIGHTS

Manufacturing faces a tough year, but 2025 looks more hopeful
- Jack Loughney

India: A vibrant ecosystem for cost-effective Bioplastics production - Dr. Ashvini Shete

Shifting into the circular economy- the oil and gas companies story - Dr Sameer Joshi and Sharad Ambadkar

From concept to comfort: The evolution of PVC flooring
- Arvind Goenka

India: A vibrant ecosystem for cost-effective Bioplastics production

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PLASTIC production has surged since the 1970s, outpacing other materials. Predictions show global primary plastic production reaching 1,100 million tonnes by 2050 if current trends persist. The shift to single-use plastics is alarming, constituting 36% of total plastic production, with 85% ending up as waste. Notably, 98% of these single-use plastics are derived from fossil fuels, contributing to a forecasted 19% share of the global carbon budget by 2040 for greenhouse gas emissions associated with their production and disposal. In 2022, global plastic production reached 400.3 million tonnes, with fossil-based plastics contributing 362.3 million tonnes and bio-based plastics 2.3 million tonnes. Only about 9% of plastics were recycled, and circular plastics made up roughly 9.6% of global production.

In 2022, the world has generated around 2.07 billion tons of total waste, out of which 12% is plastic waste which is approximately 248 million tonnes (60% of the plastic produced). Globally, less than 10% of the plastic is recycled. A significant portion is either lost to the environment or transported long distances for burning or dumping. Every year 19-23 million tons of plastic waste leaks into aquatic ecosystems, polluting lakes, rivers, and seas. Plastic pollution creates environmental, social, economic and health risk problems, thereby directly affecting millions of people's livelihoods, food production capabilities and social well-being alongside other environmental stresses like climate change, ecosystem degradation and resource use.

While useful, plastics' durability and resistance to degradation pose environmental and health risks. Over 3,200 plastic-related chemicals are identified as potentially hazardous including monomers, additives, processing aids and (Ex. BPA, cadmium, lead, microbeads, PFASs, PFOS, PFOA, etc.). These chemicals are linked to a wide range of acute, chronic, or multi-generational toxic effects, various types of cancer, genetic mutations, developmental toxicity, endocrine system disruption etc. For example, styrene and bisphenols cause non-Hodgkin's lymphoma and sexual dysfunction respectively. Most plastics break down into

microplastics, entering the human body and accumulating in organs. Microplastics have been found in lungs, livers, spleens, and kidneys, even in newborn babies' placentas.

Globally, there's a commitment to addressing the harm caused by single-use plastics and non-biodegradable products. In India, heightened plastic usage due to industrialization and urbanization emphasizes the need for responsible plastic management to prevent environmental repercussions.

Bioplastic as a sustainable alternative

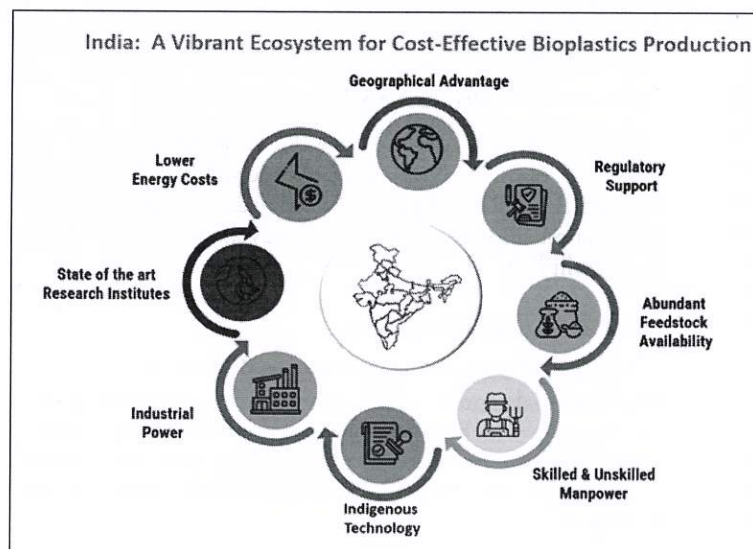
Bioplastics offer a sustainable solution to plastic for certain applications. Bioplastics like PLA & PHA along with TPS, Cellulose offer functionality advantages including biodegradability & compostability. These alternatives support circular economies and reduce reliance on finite fossil fuels (De-fossilization). While replacing all fossil-based plastics is challenging, prioritizing non-recycled single-use plastics with a >5-year lifespan with bioplastic is crucial.

Currently, bioplastics make up less than 1% of the annual 400 million tonnes of plastic produced. Market data from European Bioplastics and the nova-Institute suggests a substantial increase, with global bioplastics production expected to reach 6.3 million tonnes by 2027, up from 2.2 million tonnes in 2022. South-east Asia is currently the hub for bioplastics production due to low production costs & favourable ecosystem. India, with its cost-effective production environment, government support, and abundant resources, has potential to emerge as a global bioplastic hub.

India has a potential to become Bioplastics Hub

India being an agricultural powerhouse & expanding industrial landscape, stands to benefit significantly from embracing bioplastics. With the presence of a supportive ecosystem, comprising research institutions, industrial collaborations, developed plastic processing infrastructure,

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and a strong backbone of industrial biotech companies India is well-placed for the efficient production of bioplastics.

- Feedstock availability

India's agricultural landscape provides a vast and diverse array of feedstocks for bioplastics, including sugarcane, grains, and agricultural/food waste. Utilizing these resources for bioplastic production can not only ensure a sustainable supply chain but also contribute to the rural economy.

- Technology

Significant investments in Research and Development (R&D) are made, fostering collaboration between research organizations, corporate R&D, and public-private partnerships (PPP) in biotechnology, chemistry, and engineering.

- Expertise

Leveraging its demographic advantage, India is capitalizing on a skilled and competent workforce in Science, Technology, Engineering, and Mathematics (STEM). A harmonious blend of manual operations and automation will enhance efficiency.

- Production ecosystem

Ensuring access to power, water and land at competitive prices is crucial for creating a conducive production ecosystem. Developing robust transportation and logistics infrastructure will further support the industry's growth.

- Plastic processing industry

Facilitating ease of doing business is essential, coupled with leveraging the advantages of an already established plastic processing industry in the country. The plastic processing industry in India is quite old and developed. Bioplastic compounders can benefit from the already

developed know-how and infrastructure for developing various bioplastic formulations. Access to advanced manufacturing technologies will enhance the overall competitiveness of the sector.

- Policies

The implementation of the single-use plastic ban worldwide, and an ambitious Biomanufacturing initiative by the Government of India is serving as a facilitating driver for bioplastics production. On August 12, 2021, the Plastic Waste Management Amendment Rules, 2021, were enacted, prohibiting specific single-use plastic items with low utility and high littering potential starting from July 1, 2022. India is part of the intergovernmental negotiating committee (INC), which is convened by United Nations Environment Assembly (UNEA), developing an international legally binding instrument on plastic pollution, including in the marine environment, based on a comprehensive approach that addresses the full life cycle of plastic.

Recent Initiatives by the government of GOI to foster Biomanufacturing

- The Department of Biotechnology (DBT) aims to integrate scientific and technological progress to realize the overarching goal of BioE3 policy - Biotechnology for Economy, Environment, and Employment. This initiative seeks to contribute to a green, clean, and prosperous India.
- Ease of doing business: India's Ease of Doing Business ranking jumped from 142nd in 2015 to 63rd in 2022. With record foreign inflow of US\$83.6 billion in FY 2022 and a projected US\$100 billion in FY 2023, India's economic reforms are driving growth. S&P Global forecasts 6.5% growth in 2024-25 and 7% in 2026, positioning India as an attractive foreign investment hub set to overtake China by 2024. By 2027, India is expected to become the world's third-largest economy, surpassing Japan and Germany, with a GDP exceeding US\$5 trillion, according to IMF estimates.
- The Central Pollution Control Board enforced Plastic Waste Management Rules, 2016, directing E-commerce, the plastic industry, and raw material manufacturers to phase out specific items. The Ministry of Housing & Urban Affairs issued a detailed advisory for India's commitment to eliminate single-use plastic by June 30, 2022, including cleaning drives and tree plantations.

India can foster an environment conducive to the growth and development of the bioplastics industry, positioning itself as a hub for sustainable plastic solutions.

Path forward

- Awareness

Educating consumers and industries about the benefits of

bioplastics is crucial. Awareness campaigns can dispel myths, promote responsible consumption, and encourage the adoption of bioplastic products. Make producers and consumers aware of the problems of plastic waste and its toxic effects on environment and human health.

- Biobased & Compostability Labels and Certifications

Establishing clear standards for bioplastics through biobased and compostability labels and certifications is essential. These labels can guide consumers and businesses in making environmentally conscious choices.

- New Material Development

Invest in research and development to encourage the creation of innovative bioplastic materials. Foster collaboration between research organizations, industry, and academia to accelerate the discovery and development of sustainable materials. This can be achieved through targeted funding, grants, and incentives for companies engaged in pioneering bioplastic research.

- End-of-Life Management Systems

Implement effective end-of-life management systems for bioplastics to ensure proper disposal, recycling, or composting. Invest in infrastructure for waste collection, segregation, and recycling facilities specific to bioplastics. Public awareness campaigns can educate citizens on the proper disposal methods, promoting responsible consumer behaviour.

- Boost to Biomanufacturing

Provide support and incentives to biomanufacturing processes for the production of bioplastics. Foster partnerships between government agencies, research institutions, and private enterprises to streamline regulatory processes and create a favourable ecosystem for bioplastics manufacturing. Financial incentives and tax benefits can further encourage the adoption of biomanufacturing technologies.

- Governmental support through favourable policies & regulatory structure

A few of the European Governments are trying to implement green taxes and stringent regulations on conventional plastics. The Digital Product Passport (DPP) is a transformative initiative designed to foster sustainability and circularity within the European Union. It captures essential product information, encompassing its entire lifecycle from design to end-of-life. Introducing similar policies in India can drive the adoption of bioplastics and create a level playing field for sustainable alternatives.

Challenges

- Cost-Effective Production

Availability of cost-effective Raw Material, novel & efficient technology at commercial scale will decide the cost of production. Development of innovative use cases for certain application sectors also will play an important role in affordability.

- Incentives to Use Bioplastics

The use of biobased material as well as its use in fossil-based materials comes with many advantages including the cost benefits which are not considered traditionally. New robust system to take into consideration the waste management cost and health impact costs needs to be developed.

- End of Life Scenario Clarity

Waste Management Infrastructure: Integration into existing waste systems and the need for specific disposal conditions create challenges.

Lack of Standardization: Absence of clear guidelines for disposal and recycling hampers efficient waste management.

Environmental Impact Assessment: Thorough life cycle assessments are needed to clarify the overall environmental benefits of bioplastics.

- Labelling

One of the challenges in promoting bioplastics is the lack of standardized labelling. Establishing clear and uniform labelling for bioplastic products can enhance consumer awareness and facilitate informed choices.

- Waste Segregation and logistics

Effective waste segregation practices are essential for ensuring that bioplastics end up in the appropriate waste streams. Public awareness campaigns and infrastructure development for waste management like industrial composting facilities are imperative to address this challenge.

Conclusion

In conclusion, India stands out as a vibrant ecosystem for cost-effective bioplastics production, and Praj Industries has emerged as a key contributor to this thriving sector. Praj's commitment to innovation is evident through its development of cutting-edge technologies for bioplastics like polylactic acid (PLA) and polyhydroxyalkanoates (PHA). The company's technological prowess is showcased in its feedstock-agnostic multiproduct approach, providing versatile solutions for bioplastics production. Praj's expertise extends to end-to-end technology solutions. Furthermore, the establishment of the Parimal and Pramod Chaudhari Center of Excellence and Innovation (PPC-COEI) at the