Bioresources Development Conference (BDC26)
NABDA
Journal of Biotechnology Research
ISSN: 1119-0531
Special Issue Vol. 5(2): (2026)

A Review on Bioplastics in Nigeria: Opportunities, Challenges, and Future Prospects

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Article ID: NJBR-BDC26-A009 | Received: 18 January, 2025 | Accepted: 27 January, 2025

ABSTRACT

Plastics have become indispensable in modern society, yet their persistence in the environment poses significant ecological and public health concerns. In Nigeria, plastic waste is increasingly visible, manifesting in urban flooding caused by clogged drainage systems and in the marine litter that threatens aquatic life and coastal livelihoods. The growing global interest in bioplastics, defined as plastics derived from renewable biological resources, offers a promising pathway toward sustainable materials and circular economies. This paper reviews global and local perspectives on bioplastics, with particular focus on Nigeria's plastic pollution crisis, available feedstock potential, production readiness, key challenges and prospects. Nigeria's abundant production of cassava, maize, and sugarcane offers considerable opportunities for bio-based polymer feedstocks. However, high production costs, inadequate infrastructure, low public awareness, and weak regulatory frameworks continue to hinder widespread adoption. With stronger policy incentives, strategic public-private partnerships, and the commercialisation of existing research, Nigeria can emerge as a regional leader in bioplastic production and contribute meaningfully to achieving the Sustainable Development Goals (SDGs).

Key words: Bioplastics, Nigeria, Cassava, Circular Economy, Sustainability, Plastic Waste.

INTRODUCTION

Bioplastics, defined as plastics derived from renewable biological feedstocks such as starch, cellulose, and the products of microbial fermentation, are increasingly studied as alternatives to conventional petrochemical-based plastics (Keshavarz & Roy, 2010). In the Nigerian context, bioplastics represent both a necessity and a strategic opportunity: they can reduce reliance on fossil-fuel-derived materials, mitigate environmental pollution, and create value chains across agriculture and biotechnology sectors. This review examines Nigeria's position within the global bioplastics landscape, evaluates the country's feedstock endowment and research capacity, and proposes a forward-looking policy roadmap for bioplastic development.

Global plastic production has grown exponentially since the 1950s. By 2016, annual production had reached approximately 335 million tonnes, with an average growth rate of 8.6% translating to an increase of roughly 1.7 million tonnes per year (Guo *et al.,* 2020). The use of plastic materials continues to rise owing to their low cost, widespread accessibility, and broad range of applications. The COVID-19 pandemic further exacerbated plastic waste generation, as demand for single-use protective and medical items surged worldwide (Meysam, 2024). With poor disposal mechanisms, low recovery rates, and growing populations, the volume of plastic waste accumulating in the environment continues to increase at alarming rates. Plastics disposed of on land undergo weathering processes–including UV radiation and hydrolysis that cause gradual fragmentation into increasingly fine particles. This degradation pathway ultimately produces microplastics, tiny particles smaller than 5 mm in diameter, which have been detected in soils, water bodies, and even the human food chain (Guo *et al.,* 2020; Alawode *et al.,* 2024).

GLOBAL OVERVIEW OF PLASTICS AND BIOPLASTICS

Global plastic production currently exceeds 300 million tonnes annually, with nearly half of this volume used in single-use products (Jamshidian *et al.,* 2010). Improper disposal has resulted in severe environmental degradation, including pervasive ocean litter and widespread microplastic

contamination. Nigeria mirrors this global pattern, with urban centres such as Lagos generating over 870,000 tonnes of plastic waste each year (AP News, 2025).

Bioplastics are increasingly recognised as viable alternatives to conventional plastics, particularly in Europe, Asia, and South America, where regulatory pressures and consumer demand have accelerated their uptake. Brazil, for example, leverages its large-scale sugarcane industry to produce bio-polyethene, while Thailand is a leading producer of starch-based bioplastics. These international models offer instructive lessons for Nigeria, where equivalent agricultural commodities, particularly cassava and maize residues, could serve as competitive feedstocks for bioplastic production. The global bioplastics market has grown steadily, driven by legislation targeting single-use plastics, corporate sustainability commitments, and advances in biopolymer chemistry. Continued investment in this sector is expected to reduce the cost differential between bio-based and petroleum-based plastics over time, making the transition increasingly viable for developing economies such as Nigeria.

NIGERIA'S PLASTIC POLLUTION CHALLENGE

Nigeria's plastic waste crisis is severe and multifaceted. With a rapidly growing population, accelerating urbanisation, and limited formal waste management infrastructure, packaging waste, particularly sachet water bags and polyethene terephthalate (PET) bottles, dominates the country's waste stream. Lagos alone is estimated to generate over 60 million sachet water bags daily (AAE Africa, 2021). These plastics frequently clog drainage channels, contributing to urban flooding events and associated public health risks.

Brand audits conducted by SRADev Nigeria revealed that PET bottles and plastic sachets collectively accounted for 99% of plastic waste identified in selected Lagos communities (Nature News Africa, 2025). The prevalence of these items reflects a consumption culture in which affordable single-use plastics fill critical gaps in water distribution and food packaging, making demand-side interventions particularly challenging. Beyond urban centres, improperly disposed plastics enter river systems and coastal waters, contributing to marine litter that threatens fisheries, biodiversity, and the livelihoods of coastal communities.

The public health dimensions of Nigeria's plastic waste crisis are equally concerning. Stagnant water retained by plastic-clogged drains provides breeding grounds for disease vectors such as mosquitoes, contributing to elevated rates of malaria and other vector-borne illnesses. Microplastic particles, generated through the environmental degradation of larger plastic items, have been identified in Nigerian water bodies and agricultural soils, raising concerns about their entry into the food supply chain and attendant health consequences (Alawode *et al.,* 2024), and underscoring the urgency of the feedstock discussion that follows.

FEEDSTOCK POTENTIAL IN NIGERIA

Nigeria is well-positioned to leverage its substantial agricultural resources as feedstocks for bioplastic production. Cassava, maize, sorghum, sugarcane, and rice husks are among the most promising candidates, given both their production volumes and their established relevance in biopolymer chemistry. Table 1 presents key feedstocks and their indicative production figures, providing a basis for assessing their suitability for bioplastic development.

Table 1. Potential Feedstocks for Bioplastic Production in Nigeria

Feedstock	Annual Production (MT)	Bioplastic Potential
Cassava	~60 million	High (starch-based plastics, PLA)
Maize	~11 million	Moderate (starch, PLA blends)
Sugarcane	~1.5 million	High (bio-PE, ethanol derivatives)
Sorghum	~6.5 million	Moderate (starch extraction)
Rice husks	~2.4 million	Moderate (biodegradable fillers)

Nigeria's status as the world's largest cassava producer is particularly significant. Cassava starch is a primary raw material for polylactic acid (PLA) and other starch-based bioplastics, and the country's production volumes, estimated at approximately 60 million metric tonnes annually, provide a substantial and renewable feedstock base. Local research has already demonstrated proof of concept: scientists have developed cassava-starch-based bioplastic

films reinforced with PLA (Ogunrinola & Akpan, 2018) and bioplastics derived from maize cob waste (Zap Journals, 2022). These studies affirm Nigeria's scientific capacity to pioneer indigenous bioplastic solutions rooted in local agricultural resources.

Using agricultural waste such as cassava peels, maize cobs, and rice husks as feedstocks offers additional economic and environmental benefits by converting low-value residues into high-value biopolymers while reducing agricultural waste burdens on rural communities. Scaling these applications will require investment in processing infrastructure and the development of reliable supply chains linking farming communities to bioplastic manufacturers.

TYPES OF BIOPLASTICS AND POTENTIAL APPLICATIONS

Bioplastics constitute a diverse family of materials distinguished by their biological origin, biodegradability profiles, and end-use applications. The principal categories relevant to Nigeria include:

- **Polylactic Acid (PLA):** Derived from the fermentation of starch-rich crops such as cassava and maize, PLA is suitable for food packaging, disposable cutlery, and biomedical applications. It is fully biodegradable under industrial composting conditions.
- **Polyhydroxyalkanoates (PHAs):** Produced through microbial fermentation of organic substrates, PHAs are fully biodegradable under natural conditions, including in soil and marine environmentsHAs are fully biodegradable under natural conditions, including in soil and marine environments. They are particularly valuable for applications where conventional composting infrastructure is unavailable.
- **Starch-Based Plastics:** Thermoplastic starch blends are cost-effective and suitable for short-lifespan packaging and agricultural films. Their relatively lower mechanical strength compared to synthetic polymers limits their use in demanding applications.
- **Bio-PET and Bio-PE:** These drop-in bio-based substitutes are chemically identical to their petroleum-derived counterparts and are compatible with existing recycling infrastructure, offering a lower barrier to adoption in industrial contexts. In Nigeria, the most immediate and impactful applications of bioplastics would involve substituting the single-use items that dominate the waste stream. Sachet water packaging, shopping bags, food service items, and agricultural mulch films represent priority targets. Successful adoption in these segments would yield immediate environmental dividends while building the market foundation for broader industrial uptake.

PRODUCTION READINESS AND SWOT ANALYSIS

Nigeria's readiness to develop a domestic bioplastics industry is characterised by a mix of encouraging strengths and significant structural weaknesses. Several institutions, including the National Biotechnology Research and Development Agency (NBRDA), the Federal Institute of Industrial Research Oshodi (FIIRO), and the National Research Institute for Chemical Technology (NARICT), are actively engaged in bioplastic research and development. The African University of Science and Technology (AUST) has also recently formalised a partnership with NBRDA to advance biomaterials research (AUST, 2024). Nevertheless, large-scale commercial production remains absent, and the gap between laboratory-scale research and industrial deployment is substantial. Table 2 presents a SWOT analysis of the bioplastics sector in Nigeria.

Table 2. SWOT Analysis of Bioplastics Development in Nigeria

Strengths	Weaknesses	Opportunities	Threats
Abundant cassava and maize production	High production costs relative to conventional plastics	Potential for regional leadership in West Africa	Policy inconsistency and weak enforcement
Large and growing domestic market	Weak processing and logistics infrastructure	Job creation and farmer income diversification	Competition from cheap plastic imports
Established R&D institutions (NBRDA, FIIRO)	Low consumer awareness and demand	Alignment with the SDGs and AfCFTA trade frameworks	Volatility in global oil prices affecting competitiveness

The SWOT analysis highlights that while Nigeria's agricultural endowment and institutional research capacity provide a firm foundation, realising the sector's potential will require deliberate policy intervention to address cost barriers, infrastructure deficits, and regulatory weaknesses. Closing the gap between research output and commercial production will be central to any credible bioplastics development strategy.

ADVANTAGES OF BIOPLASTICS IN THE NIGERIAN CONTEXT

The adoption of bioplastics in Nigeria carries advantages across multiple dimensions:

- **Environmental Benefits:** Biodegradable bioplastics reduce the accumulation of persistent plastic litter, thereby mitigating urban flooding, marine pollution, and microplastic contamination of soils and water bodies.
- **Economic Benefits:** A domestic bioplastics industry would create new agro-industrial value chains, generate employment along the agricultural supply chain, and reduce the foreign exchange costs associated with importing petrochemical plastics.
- **Public Health Benefits:** Reduction in plastic-related flooding and stagnant water would lower exposure to vector-borne diseases, while decreased microplastic contamination of food and water would address emerging dietary health risks.
- **Alignment with Global Frameworks:** Bioplastic development directly supports the achievement of United Nations Sustainable Development Goal 12 (Responsible Consumption).

CHALLENGES TO BIOPLASTIC ADOPTION IN NIGERIA

Despite their considerable potential, bioplastics face substantial barriers to adoption in Nigeria. Understanding these challenges is essential to designing effective interventions. The cost of producing bioplastics currently remains significantly higher than that of conventional petroleum-derived plastics. This price disparity discourages investment and makes bioplastic products uncompetitive in a market where affordability drives purchasing decisions. Without targeted financial instruments such as subsidies, tax incentives, or concessionary financing, the economics of bioplastic production are unlikely to attract private-sector interest at scale.

Nigeria's regulatory environment presents further obstacles. Earlier attempts to implement bans on single-use plastics have encountered persistent resistance from industry stakeholders and have been undermined by weak enforcement capacity (Reuters, 2024). The absence of robust, consistently enforced environmental regulations reduces the urgency for businesses to transition away from conventional plastics. Complementary measures such as extended producer responsibility schemes and mandatory recycled content standards are largely absent. Infrastructure gaps compound these policy weaknesses. Nigeria lacks the processing facilities, cold chains, and logistics networks required to support an integrated bioplastics supply chain, from agricultural feedstock collection through to biopolymer processing, product manufacturing, and end-of-life management. Inadequate waste sorting and collection systems also limit the effectiveness of composting-based end-of-life pathways for biodegradable bioplastics. Low consumer awareness and limited institutional knowledge about bioplastics constrain demand. Many consumers, businesses, and even policymakers are unfamiliar with the distinctions between different types of bioplastics, their appropriate applications, and their correct disposal. Without a well-informed consumer base, market demand for bioplastic alternatives will remain limited.

FUTURE PROSPECTS AND POLICY ROADMAP

Developing a viable bioplastics sector in Nigeria will require coordinated action across government, industry, academia, and civil society. The following strategic priorities are proposed as a policy roadmap:

Policy Incentives: The Federal Government should introduce fiscal incentives including tax holidays, import duty waivers on bioplastic production equipment, and subsidies for feedstock processing to lower the cost of entry for domestic bioplastic producers. Simultaneously, plastic bans must be accompanied by plastic enforcement mechanisms and transition timelines.

Public-Private Partnerships: Nigeria should pursue strategic partnerships between government agencies, research institutions, and private investors to establish demonstration plants and pilot-scale bioplastic production facilities. These partnerships can de-risk early-stage investment and provide

proof of concept at commercial scale.

Regional Integration through AfCFTA: Nigeria should leverage the African Continental Free Trade Area (AfCFTA) framework to develop regional markets for domestically produced bioplastics, positioning itself as a supplier to other West African economies that face similar plastic waste challenges.

Awareness and Education: Develop comprehensive public awareness campaigns targeting consumers, retailers, and waste management actors to build understanding of bioplastics, their environmental benefits, and appropriate disposal pathways. School and university curricula should incorporate sustainability and circular economy principles.

Research Commercialisation: Institutions such as NBRDA, FIIRO, and NARICT should support existing research through dedicated commercialisation pathways, including technology transfer offices, innovation funds, and industry linkage programs. The recently established AUST-NBRDA partnership in biomaterials research (AUST, 2024) represents a promising model that should be expanded and replicated.

CONCLUSION

Bioplastics represent a realistic and strategically significant pathway for Nigeria to address its deepening plastic pollution crisis, strengthen its agricultural and industrial sectors, and make meaningful progress toward its sustainability commitments. With an unparalleled cassava production base, a growing body of domestic research, and increasing public and institutional awareness of the environmental costs of conventional plastics, Nigeria possesses the foundational elements required to develop a competitive bioplastics industry. However, realising this potential demands more than scientific capacity; it requires aligning policy, investment, infrastructure, and public engagement in a coherent national strategy. Without strong regulatory frameworks, sustained infrastructure investment, and deliberate efforts to raise consumer awareness, the sector risks remaining confined to research laboratories while Nigeria continues to bear the social, environmental, and economic costs of plastic pollution. Moving forward, multi-stakeholder collaboration linking federal and state governments, research institutions, the private sector, civil society, and international development partners is indispensable to ensuring that Nigeria transitions from being one of the world's largest contributors to plastic waste into a regional pioneer of sustainable bioplastic alternatives.

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How to Cite This Article

Aliyu, A.A., Igbawua, J.P., Ibrahim, B.J., Mohammed, M.T., Sani, T. & Aqiba, R. U. (2026). A Review on Bioplastics in Nigeria: Opportunities, Challenges and Future Prospects. *NABDA Journal of Biotechnology Research*, 5(2), 85-90.