

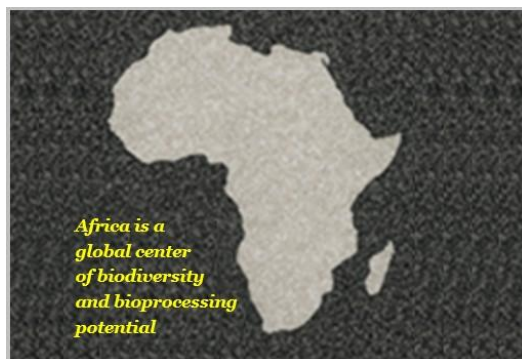
From Biodiversity to Bioeconomy: Positioning Africa at the Forefront of Natural Product-Based Sustainability

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Abstract: Africa's vast biodiversity, spanning forests, mangroves, and coral reefs, hosts over 40,000 plant species, many with medicinal and aromatic properties. Yet, this natural wealth has not translated into economic resilience. While global demand for natural and low-carbon products continues to rise, Africa remains largely an exporter of unprocessed commodities. This editorial explores how the continent can transform its biological endowment into a driver of sustainable, inclusive growth through a bioeconomy grounded in science, standards, and equity. With nearly 80 percent of Africans depending on traditional medicine, bioprospecting and indigenous knowledge offer a powerful basis for sustainable value creation. Examples of *Allanblackia stuhlmannii* seed oil and Zanzibar's women-led seaweed farming illustrate how biodiversity-based enterprises can align conservation with competitiveness, linking regenerative practices to fair benefit-sharing and market access. From successful case studies, five pillars were identified for advancing Africa's bioeconomy, namely, reinforcing science and quality standards at source, securing traceability and fair benefits, aligning finance with biological rhythms, scaling local manufacturing, and strengthening trade diplomacy to build market confidence. Ultimately, Africa's transition from raw-material supplier to bio-industrial innovator depends on investing in human capital, research, and regional integration. By coupling ethnobotanical heritage with modern science and fair trade, Africa can lead a global shift toward a nature-positive economy-one that restores ecosystems, empowers communities, and redefines biodiversity as a foundation for prosperity rather than a static inheritance.



Keywords: Africa, biodiversity, bioeconomy, biological, natural products, sustainability

Africa, the world's second-largest continent is home for the planet's most extraordinary natural wealth. Its forests, mangroves, grasslands, and coral reefs support nearly 45,000 plant species, of which about 6,000 are valued for their medicinal or aromatic properties.^{1,2,3} In regions such as the Congo Basin and the Serengeti, communities have developed extensive traditional medicinal knowledge over centuries. Yet, this abundance has not translated into lasting prosperity. While Africa's exports have long centered on raw materials like oil, minerals, and unprocessed crops, global markets have moved decisively toward natural, traceable, and low-carbon goods, including botanicals and plant-based pharmaceuticals. Despite its comparative advantages, Africa contributes only marginally to the global herbal medicine market, valued between USD 70-230 billion annually.^{4,5}

The challenge is therefore not one of potential, but of strategic positioning: how to convert biodiversity from passive inheritance into an active engine of innovation and inclusive growth. Bioprospecting defines as the exploration and sustainable use of biological and genetic resources offers a pathway for this transformation. Traditional healing, deeply rooted in communal life, offers an integrative model of health in which nature, mind, and body are inseparable. Moving from conservation-as-protection to conservation-as-competitiveness will require regional integration, science-based standards, and strengthened research capacity.



Figure 1. *Bridelia* species, about 60 species known in Africa, providing habitat and resources for various fauna.

1. Opportunity

Natural products offer unique qualities, including biodegradability, renewability, chemical novelty, and alignment with global sustainability trends. Africa, and South Africa in particular, possesses a rich reservoir of indigenous plants, fungi, and marine organisms with potential applications across emerging sectors such as bioplastics, nanomaterials, green catalysts, pharmaceuticals, nutraceuticals, fragrances, and

Dr. Gerda Fouché is an accomplished natural products chemist with more than 30 years of scientific research experience. She previously served as the Scientific Innovation Leader for the Natural Product Group at the CSIR Biosciences, where she oversaw group administrative functions, provided scientific leadership and mentorship, and managed large, multidisciplinary research projects. Her work at the CSIR focused on the discovery and development of drug and natural-product leads derived from South Africa's rich biodiversity. Dr. Fouché is currently an Extraordinary Lecturer in the Department of Chemistry, Faculty of Natural and Agricultural Sciences, at the University of Pretoria. Her research centers on the organic chemistry of medicinal plants, with an emphasis on the purification, isolation, and structural elucidation of biologically active compounds. She serves on the advisory board of the journal *Innovation of Chemistry & Materials for Sustainability* from its inception. As a dedicated natural product chemist, Dr. Fouché is deeply passionate about Africa's biodiversity. She advocates for its conservation and for building a sustainable bioeconomy that benefits communities across the continent.



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Figure 2. *Crinum* is a genus of about 180 species of perennial plants that have large showy flowers on leafless stems, and develop from bulbs.

cosmetics. Natural products should thus be recognized not only as sources of drugs but as platforms for next-generation functional and biological materials. Nearly 80% of people in the WHO African Region rely on traditional medicine for primary healthcare,⁶ underscoring the depth of biological and cultural knowledge that can drive new value chains. Examples such as *Allanblackia* seed oil and Zanzibar's women-led seaweed sector illustrate how biological resources can anchor regenerative enterprises, promote local value addition, strengthen competitiveness, and enable fair benefit-sharing.

A. *Allanblackia stuhlmannii*: A No-Deforestation Value Chain

Allanblackia, native to East African forests, has transitioned from an overlooked species to a commercially valuable source of stearic- and oleic-rich oil used in spreads and cosmetics. Its safety has been evaluated by the European Food Safety Authority.^{7,8} Community-based seed networks integrate mobile procurement, moisture testing, and grading at village depots. Quality standards are met through local pressing that controls free fatty acids and peroxide levels. Regenerative practices such as seedling nurseries, assisted regeneration, and participatory forest management are tied to transparent benefit-sharing with price floors and social-fund allocations. Conservation premiums reward biodiversity-positive stewardship.

B. Zanzibar Seaweed: A Women-Led Blue Economy

In Zanzibar, women produce up to 88% of farmed seaweed.^{9,10,11} Cultivation of *Eucheuma* and *Kappaphycus* supports global carrageenan markets and local industries in cosmetics, foods, and agricultural bio-stimulants. Seaweed requires no land, freshwater, or fertilizers and enhances marine ecosystems when responsibly managed. Governance systems emphasizing spatial planning, secure tenure, and streamlined licensing have supported this growing blue-economy sector.

2. Challenges and Mitigation

Despite its immense biological endowment, Africa faces persistent structural constraints that limit its ability to lead in natural-product innovation and biological materials development. These constraints are not merely technical but systemic, shaped by historical, economic, and policy factors:

Fragmented research efforts and insufficient infrastructure and funding

Research on natural products, biodiversity, and biomanufacturing is often conducted in isolated pockets such as universities, public research institutes, and small private laboratories that operate with minimal coordination. This fragmentation leads to duplication of work, weak knowledge-sharing networks, and limited capacity to scale discoveries into

commercially viable products. Compounding this is chronic underinvestment in scientific infrastructure: many laboratories lack modern analytical equipment, bioprocessing facilities, or reliable access to reagents and data platforms. As a result, African scientists struggle to generate high-quality, reproducible results at the pace required for global competitiveness.

Loss of biodiversity and erosion of indigenous knowledge

Africa's biodiversity which has the potential to underpin innovation in pharmaceuticals, biomaterials, cosmetics, agriculture, and green chemistry is increasingly threatened by habitat loss, climate change, and unsustainable extraction practices. Equally critical is the erosion of indigenous knowledge systems that historically guided the use of natural products and ecological stewardship. As communities lose custodial knowledge through cultural marginalization and generational shifts, the continent forfeits a vital source of insight for bioprospecting, sustainable resource management, and culturally grounded innovation.

Weak benefit-sharing mechanisms and ethical frameworks

While African countries participate in global biodiversity governance, domestic mechanisms for access and benefit-sharing (ABS) are often underdeveloped or inconsistently enforced. Local communities and knowledge holders may be excluded from negotiations, and partnerships with foreign companies or research institutions can lack transparency. These gaps increase the risk of biopiracy, discourage community participation, and erode trust in scientific research. Without robust ethical frameworks and clear compliance pathways, investors and researchers also face uncertainty that impedes collaboration and technology transfer.

Under-representation in global research, regulatory, and policy arenas

African scientists, regulators, and institutions continue to be underrepresented in international standard-setting bodies, research consortia, and biotechnology governance platforms. This limits the continent's ability to shape intellectual property frameworks, biosafety norms, and research agendas that affect access to technologies and markets. As global bioeconomy policies evolve rapidly, Africa risks becoming a rule-taker rather than a rule-maker, further constraining its strategic autonomy.

Without inclusive innovation policies, sustained domestic investment, and strong scientific ecosystems, Africa may continue exporting unprocessed biological resources such as plants, microbes, genetic materials, while value-added manufacturing, IP ownership, and wealth creation occur elsewhere. This perpetuates extractive economic models and prevents the continent from capturing the full benefits of the global shift toward bio-based industries.

What is required to shift Africa toward leadership in green chemistry and biological manufacturing?

A. Strengthening scientific and regulatory capacity

Countries need to prioritize training in synthetic biology, analytical chemistry, bioprocess engineering, regulatory science, and intellectual property management. At the regulatory level, stronger biosafety authorities, expedited research approvals, and harmonized regional guidelines would enable safe, timely innovation.

B. Investing in biological research infrastructure

Investment must extend beyond academic laboratories to include pilot-scale biomanufacturing facilities, natural product libraries, genomics centers, and computational biology platforms. Shared regional hubs similar to the African Centres of Excellence model can reduce duplication and build critical mass.

C. Formalizing indigenous knowledge systems

Indigenous knowledge must be documented, protected, and integrated into national research and development strategies. This includes community-driven protocols for data governance, ethical access, and recognition of traditional healers and custodians as research partners. Such formalization strengthens cultural legitimacy and supports science–society collaboration.

D. Ensuring transparent benefit-sharing aligned with the Nagoya Protocol

Countries should adopt clear ABS legislation, digital tracking systems for genetic resources, and community-inclusive negotiation processes. Transparent benefit-sharing including both monetary and non-monetary benefits, build trust, encourage participation, and ensure that innovation contributes to local development.

3. Way Forward

Building a competitive African bioeconomy grounded in natural products and biological innovation demands coordinated, long-term action. Five strategic pathways or pillars are essential:

A. Establish Regional Centers of Excellence

Specialized hubs in natural product chemistry, biological materials science, and sustainable manufacturing can drive research and development, set quality standards, ensure continental leadership, and strengthen regional accredited laboratories.

B. Promote Interdisciplinary Collaboration

Chemists, ecologists, materials scientists, and indigenous knowledge holders must co-create research agendas and design value chains that reflect both scientific and cultural priorities.

C. Strengthen Policy and Ethical Frameworks

Robust policies are needed to protect traditional knowledge, safeguard biodiversity, support sustainable harvesting, and uphold community rights through strong regulatory science.

D. Enable Sustainable Financing and Partnerships

Public–private partnerships, blended finance, and pan-African investment mechanisms are required to support early-stage research, pilot manufacturing, and responsible scale-up.

E. Empower Local Communities and Innovators

Communities, women, and youth as custodians of biological and cultural knowledge must be positioned as central beneficiaries of emerging biological industries. Across all pillars, investment in skilled human infrastructure, ethnobotany, ecology, natural products chemistry, regulatory affairs, and entrepreneurship is indispensable. This shift demands movement from extraction to empowerment, from raw-material supply to research leadership. Models such as *Allanblackia* and Zanzibar seaweed farming demonstrate the potential of regenerative, inclusive value chains.

A robust strategy for using biodiversity in the bioeconomy begins with establishing a clear baseline assessment of local species, ecosystems, and biological resources. The way forward for project strategies is to design biodiversity initiatives around regenerative resource use and adaptive management principles. Tracking should be strengthened through standardized ecological and socioeconomic indicators supported by digital tools such as GIS and remote sensing. Transparent monitoring systems must be integrated to ensure real-time data flow and enable rapid detection of ecological or operational changes. Updating processes should follow routine review cycles that incorporate monitoring results, new scientific evidence, and evolving policy conditions. Together, these

steps will ensure that biodiversity-based bioeconomy projects remain responsive, accountable, and resilient over time.

4. Conclusion

Africa's biodiversity is far more than ecological heritage, it is a powerful innovation engine capable of driving a regenerative, inclusive bioeconomy. With strategic investment in research and development, equitable value chains, regional integration, and scientific excellence, Africa can evolve from a supplier of raw materials to a global leader in natural-product-based and biological materials innovation. The question is no longer whether Africa can lead, but how quickly it can build the systems required for leadership. By transitioning from extraction to standards-driven value creation and from isolated production to regionally integrated innovation, Africa can shape the future of sustainable bio-industries and establish itself as the engine room of a nature-positive global economy.

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Data Availability Declaration

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Notes

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